THE GLASS INDUSTRY
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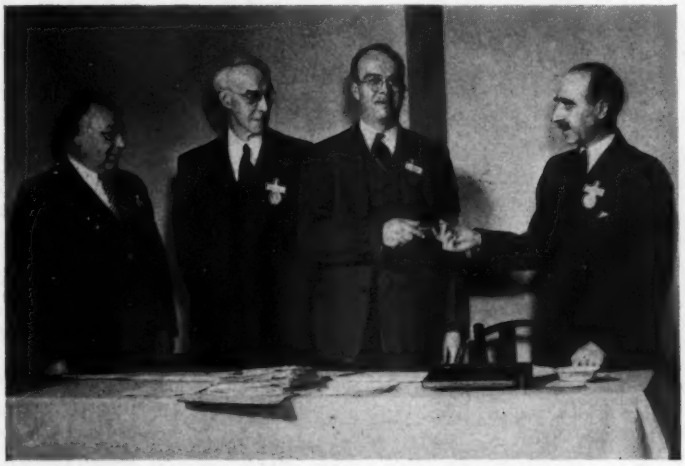
GLASS DIVISION HOLDS TWENTY-SEVENTH ANNUAL MEETING DURING A. C. S. CONVENTION

The Glass Division of the American Ceramic Society participated in the largest general meeting and its own largest technical session in Buffalo, April 28 to May 1. At numerous times 200 members were in attendance. It is well that the Division was assigned for its meeting room to the assembly hall on the top floor of the Statler, even though the place seemed so remote that road signs would have been useful.

A total of 26 papers were actually presented and it was only because of the skill of Chairman Louis Navias, General Electric Company, in using every device to save time that the technical sessions were completed with opportunity for the business meeting on Tuesday afternoon, and the biennial session of the Committee C-14, A.S.T.M. on Wednesday afternoon.



Passing of the Glass Gavel. Louis Navias, retiring chairman of the Glass Division passes the gavel to O. G. Burch, chairman for 1946-47. Looking on, F. R. Brenner and S. R. Scholes.

The technical papers were unusually good in variety and content. Inasmuch as summaries appear elsewhere in this journal, no attempt will be made to discuss each paper separately. It is worthy of remark that the program offered an epitome of advances in glass technology, including studies of the physical properties of glasses, represented by durability, density, surface tension, hardness, strength (fibers) and certain optical characteristics; the dielectric properties, constitution and devitrification of glasses. Further variety in such matters was offered by discussions of electrical glass melting, the insulation of tanks, and a completely novel use of glass for supplying nickel ions to stimulate the charging of storage batteries. A paper on plastics came in when no one was looking but it proved to be interesting enough to pay its way. A surprise feature—if anything Jim Bailey did could be surprising—was the exhibition of a wedge made of stressed plastic suitable for replacing the usual quartz wedge in polariscopes for strain analysis.

The operating technologists or glass engineers were ably represented by Foss Curtis, Fostoria Glass Company, who discussed the difficulties encountered in producing good glass with insufficient and even inferior help. The somewhat plaintive note in this report was continued by other members in the discussions which followed.

Miss Anna J. Harrison, Corning Glass Works, with her interesting paper on the effect of water content on infrared transmission of simple glasses, which was only the second paper thus far presented by a woman before the Division, demonstrated that she could hold her own in the technical debate which ensued.

The paper by Howard R. Swift, Libbey-Owens-Ford Glass Company, on crystal growth was particularly interesting because of the numerous informative graphs which he exhibited, throwing much light on a hitherto somewhat qualitative subject. He reported the identification of a new crystal phase in glasses containing magnesia. This paper is one that should be read with a great deal of interest upon its publication.

Any who may have expected to hear about large-scale

Ralph F. Brenner

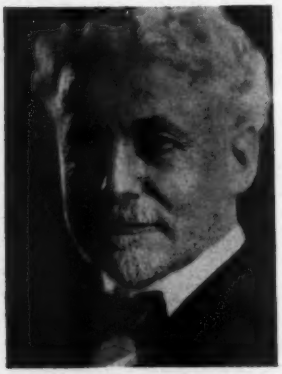
glass melting by electricity must have overlooked the word "laboratory" in the title, because W. A. Hedden, General Electric Company, discussed and illustrated a furnace whose melting cavity could be practically filled by an ordinary fire brick. Nevertheless, the news concerning its performance and characteristics was worth hearing.

The technique of determining glass density by the sink-float method described by R. D. Duff, Owens-Illinois Glass Company, seems to have developed a jargon all its own. Since the density of the oil used as the immersion liquid is controlled by controlling its temperature, the density of the glass, or more properly the changes in its density, are expressed as small temperature intervals. These can be translated into density differences, but the more advanced operators seem not to bother.

Charles S. Pearce

An excursion into another field which occupies a middle ground between glass and organic chemistry was furnished by the display and discussion of silicones by Shailer L. Bass, representing Corning Glass Works and Dow Corning Corporation. It is not often that a completely useless material comes in for as much attention as that accorded the "silicone putty". This stuff can be pulled into a sloppy thread, torn into chunks, welded together again, then rolled into a ball and bounced off the floor. When it is restored to its little tin box, it slowly flows into a flat mass again in the repose of utter uselessness.

Analytical operations were given some promotion in the paper already published by B. B. Osterhaus, Libbey-Owens-Ford Glass Company. As we acquire more erudition and catch up a little bit with the fine-structure boys, it is apparent that many of the phenomena of glass melting and glass working will acquire better explanation. This became evident in the discussion by N. J. Kreidl, Bausch and Lomb Optical Company, on the constitution of extra-dense flint glasses. Dr. Kreidl also entertained the Division with some excellent pictures taken by electron microscope, showing defects on polished glass surfaces that could not otherwise have been identified.



Ross C. Purdy

The above sampling will suffice to show how thoroughly diversified and full of stimulus for the technologist and researcher the program proved to be.

Oscar G. Burch

At the business meeting, committee reports were read. Tentative plans were made for the summer meeting and the visit of Professor W. E. S. Turner, of Sheffield, was announced for the coming summer. The officers elected for the coming year are: O. G. Burch, Owens-Illinois Glass Company, Chairman, promoted from the job of making program, which he did so well; R. F. Brenner, Anchor-Hocking Glass Corporation, a member of the Division since its organization, Vice-Chairman in Charge of Program; and S. R. Scholes, N.Y.S. College of Ceramics, Secretary.

The highlight of the general meeting was the testimonial dinner honoring Ross C. Purdy, who retired as General Secretary. More than 600 guests were in attendance, and the speeches gave an impressive account of the life and accomplishments of the man who has been the guiding spirit and driving force in the Society for a quarter of a century. Dr. Purdy was presented with an automobile, represented in token by a toy car, together with a check for more than $1,600, the over-subscription, with which to buy gasoline. The Buffalo ceramists, as hosts, did a splendid job at entertaining.

Following are summarizations of those papers which were made availble to THE GLASS INDUSTRY for the purpose:

A Study of Factors of Technique in Glass Density Determinations by a Sink-Float Method. *By R. D. Duff, Owens-Illinois Glass Company, Streator, Illinois.*

A sink-float apparatus and technique for determining daily glass densities had been in use for several years. The advent of the Knight apparatus and technique for density determination, being somewhat different, indicated that a comparison of the two procedures should be made in order to determine which would be best for factory control work.

The original technique, in brief, consisted of taking a bottle sample at the same time each day from any lehr on the furnace. A seed-free ½ inch square was cut from the sidewall and reannealed by a standard procedure. The glass samples and a standard piece of glass were placed in a tube of heavy liquid which was then placed in the water bath. The bath temperature was then raised by means of an immersion heater until all pieces of glass sank to the bottom of the tube. Heating current was then turned off and the bath temperature allowed to fall at the rate of 0.1°C. per minute. At half minute intervals, the liquid in the tube was stirred vigorously with the thermometer and, after the stirring currents had died out, the motion of each piece of glass in the tube was observed. The float temperature of each piece of glass was read on the thermometer and recorded when it was observed that the piece had a tendency to rise rather than sink in the liquid, care being taken to see that the pieces were not in contact with each

other or with the walls of the tube. Temperature readings were taken to the nearest 0.1°C. The difference observed between the float temperature of a sample and the float temperature of the standard is an index of the difference in density between the two. For samples lighter than the standard, the difference is positive and for samples heavier than the standard, the difference is negative. Density differences in terms of temperature may be converted to density units by multiplying by the factor —0.0019.

A comparison of the two methods of observing the sink-float temperatures was first made. The results showed that the differences in the mean values observed by the two methods were small for all samples; on the average, the Knight method gave values 0.04°C. heavier. For the Knight method, the standard deviation of the 20 observations on each sample varied from 0.057°C. to 0.138°C. with an average value of 0.090°C. for all 10 samples. For the original method, the standard deviations varied from 0.050°C. to 0.094°C. with an average value of 0.074°C. for all samples. The time required by both methods was practically the same and as the original method showed slightly better precision, it was retained and used in making further comparisons on other variations in technique.

A series of tests were then made in which the samples were 1) untouched by hand, 2) handled rather thoroughly and 3) scratched with a Furthite point for identification. The results of this test indicated that handling and making the samples had not caused a significant change either in the mean density or in the dispersion of the individual observations about the mean.

Based on a study of samples over a month period, the following conclusions were drawn regarding the effect of commercial annealing on density: 1) In density samples from different bottles of the same temper grade, occasional density variations as large as 0.5°C. are to be expected as a result of variations in the effect of thermal history on density. 2) Annealing effects on density differ only slightly from one location to another in commercially annealed bottles. 3) On the average, one temper unit appears to be approximately equivalent to a change in density of 0.15°C.

The results of density determinations on sets of samples cut from cord-free and cordy glass ring sections indicated a poor correlation between cordiness and dispersion of the density values.

A series of tests were made on samples taken from the furnace in the form of rods. These rods were formed by a standard procedure. The results of these tests indicated that rod samples would be satisfactory for use in density determinations for the purpose of glass composition control as they represented the glass going into the bottles and the variations in density due to varying thermal history were approximately the same as were encountered in lehr annealed samples.

A test of the rod sample technique was then applied to sampling factory production for a month period. From the results of these studies, the following procedure was recommended for glass density determination made for the purpose of glass composition control: 1) Take one sample per furnace (preferably from one selected trough or forehearth feeding a heavy pull machine), samples to be taken at regular time intervals. 2) Use a standardized rod sampling technique for obtaining samples. 3) Determine density of the samples without reannealing by the original float temperature procedure. 4) The densities so determined are suitable for direct use in any desired form of control chart without correction. 5) If desired, the density values obtained on rod samples of container glasses may be approximately corrected to their expected reannealed values by adding a correction of —4.0°C. to be observed "as drawn" density values. More accurate correction figures applicable to specific glasses may be determined experimentally if desired.

Insulation of Continuous Glass Tanks and other Glass Making Equipment. *By W. R. Kerr, Armstrong Cork Company, Beaver Falls, Pa.*

The subject of glass tank insulation is discussed in view of the improvements that have been made in the fields of refractories and insulation during the past decade. Heat balances of glass tanks show that interesting possibilities exist in fuel saving if the source of heat loss can be properly and safely insulated.

The author discussed the various parts of the glass tank and the effect of insulation on such parts. The problem of insulating the bottom blocks or the flux blocks in the melting end is an extremely difficult one. One objection is that when insulation is placed on the outside of the flux blocks, the erosive attack at the metal line is accelerated. A second objection is that when the joints are covered, the film of frozen glass in the joint is melted and allows the glass to flow out between adjacent blocks. For the successful insulation of the bottom, end wall and side walls, both a more resistant block and a more resistant mortar must be first developed. In the refining end, less severe conditions exist and it becomes possible to apply insulation to the flux blocks around the nose back almost to the bridgewall and to the bottom blocks to within about 3 ft. of the bridgewall.

To prevent freezing of the throat, it was suggested that the throat be partially insulated in a sort of checker work pattern. At the first sign of freezing at the throat, additional insulating firebrick could be slipped into the empty spaces so as to fully insulate the area and cause a building-up of temperature. When the freeze is broken, the additional brick are removed.

It has not been found practical to insulate the cap of the regenerator uptakes on certain types of furnaces operating at extremely high temperatures because the super-duty fire clay brick "burn up". Such failures occur from two main causes, the first of these being the plastic flow within the brick which allows it to soften and distort. The second cause of failure is the chemical attack by alkaline vapors. The use of basic brick in such locations is increasing and several such installations have been successfully insulated. As refractories improve, it will likely be possible to have insulated port connections and regenerator caps.

Improvements in super-refractories should pave the way for more extensive use of insulation on the walls in the melting end. Present day insulation of walls must, however, be confined to furnaces not operating at elevated temperatures, and also must be limited to furnaces in which the chemical attack is not aggravated by having alkaline dusts swirled about by turbulent conditions within the furnace. In the refining end where conditions are more suitable, it should be possible to insulate the sidewall around the nose back to within a few feet of the bridgewall. The use of insulation around the nose of the furnace not only conserves fuel but keeps the temperature in the room lower and makes for better working conditions.

Crown insulation is a controversial subject. As is the case of the silica brick in the sidewalls and ports, the possibility of insulating the crown would be greatly increased if alkaline dusts could be reduced. The new super-duty silica brick may offer some advantages in this direction. In the refining end, it should be feasible to insulate the cap over the refining chamber to within, say, 3 ft. of the bridge. Without any other regulation to the furnace, insulation over the cap would cause an increase in temperature in this part of the furnace and this would have to be offset by additions to the shadow wall.

It was emphasized that it is possible to insulate the melting end cap in many instances but that caution must be used because of the number of variables associated with glass tank construction. When the cap is insulated, it has been found possible to hold the same temperature in the melting end as when uninsulated but with less heat input. Dripping and chemical attack are, therefore, no greater and fuel is saved.

It should be considered standard practice to insulate a regenerative system of all continuous tanks and the insulation should be carried up to the arches over the regenerator chambers. Where moderate conditions prevail, these arches should be considered for insulation as should the uptakes.

In any insulation program, it should be borne in mind that many failures have occurred in glass tanks where improperly insulated, and the best plan to investigate this problem is to "make haste slowly" and avoid too great risks. It is only by this plan that costly and time consuming re-

pairs to damaged furnaces may be avoided as shown by past experience. It is believed that eventually glass tanks will be heavily insulated, but it will be evolutionary and the result of careful investigation.

Oxidation-Reduction Phenomena in Glasses. *By Alfred W. Bastress, Glass Science, Inc., State College, Pa.*

Reduction of metallic oxides in glasses and glazes is of considerable practical interest. Reduction of lead or copper has been suggested for decorative purposes and for staining glass fibers. The phenomena also occurs as a defect when lead glazes are fired under reducing conditions.

In order to study the fundamentals of these reactions a number of glasses of simple composition have been studied in combination with oxides of antimony, lead, bismuth and silver. According to theory, it was found that the reduction of the metal ions in these glasses under the influence of hydrogen is affected by the water content of the reducing atmosphere. Dry hydrogen, for instance, reduces certain glasses at a temperature which is 75°C. lower than that obtained when hydrogen gas is used which has been saturated with water at room temperature.

In all glasses studied silver oxide was reduced at the lowest temperature. Bismuth, lead and antimony were reduced at successively higher temperatures. In pure alkali silicates there is no major difference in the reduction temperature of these oxides if the acidity is increased above the ratio 1:2 (Na_2O, $2SiO_2$).

The boro-silicates exhibit maxima which indicate a strong bond of the metallic ions in certain alkali, boric oxide, silica ratios. These indications can be correlated with corresponding changes in physical properties such as thermal expansion and viscosity. Phosphate glasses seem to exert the strongest force upon ions of lead, antimony, bismuth and silver as they exhibit the highest reduction temperatures.

The work which is still in progress attempts to correlate the chemical stability of heavy metal ions with their role in the glass structure.

Some Electron Microscope Pictures of Glass Surfaces. *By N. J. Kreidl, Bausch & Lomb Optical Company, Rochester 2, New York.*

This was not a formal paper but was a showing of a very interesting series of pictures of various glass surfaces taken by means of the electron microscope using the replica technique. The electron microscope pictures shown represented unpolished surfaces, scratched surfaces (Fig. 1) and surfaces attacked by a humid atmosphere at 90°C ("dimming test") (Fig. 2).

The magnification in the R.C.S. electron microscope was about 2000. Replicas were obtained by stripping from the glass surface a polyvinyl formal ("formvar") layer.

In the case of the surfaces attacked by a humid atmosphere, the pictures showed a fern-like structure of carbonate crystals forming at certain locations only. No general attack was visible between the crystal growing areas at this magnification. This fact suggests that dimming does not start easily on perfect glass surfaces, but starts from defective areas like a disease.

Effect of Composition on Knoop Hardness of Glass. *By A. E. Pavlish and I. Mockrin, Battelle Memorial Institute, Columbus, Ohio.*

This paper covers a phase of the work which was carried out for the Office of Production Research and Development of the War Production Board on the development of glasses of increased hardness for use as instrument bearings. Nearly all the work reported in this paper was done in the alumina-silicon-borix oxide-calcium oxide system or on glasses derived from this system by substitution of various oxides, chiefly for silica.

Raw batches which gave a yield of about 200 grams of net glass were melted in either zircon or clay crucibles at temperatures of 2750°F or 2850°F. The glasses were crushed and remelted at temperatures of 2700°F to 2750°F for periods of 2 to 4 hours so as to produce homogeneous seed-free glasses. Specimens ¼ inch thick and ½ inch in diameter were formed by pouring and pressing. The pressed specimen were annealed by various procedures so as to be practically strain-free when viewed under a polariscope.

The hardness of the glasses was obtained in terms of Knoop hardness numbers by means of a Tukon Tester. In this method, a pyramid-shaped diamond is impressed upon the test specimens under a definite load (500 grams) and for a definite time (20 seconds). The Knoop, or indentation number, is the ratio of the applied load to the projected area of the indentation before removal of the load. The length of the indentation was measured with a microscope. Five measurements were made of each test specimen and the average used. Polished specimens were used in all cases.

In general, the results of this work showed that the hardness of the particular alumina-silica-boric oxide-lime glass used was affected markedly by only a few of the oxides substituted. This is significant because a large variety of oxides were employed and practically all of the substitutions were for silica in the base glass. The substitution of "modifiers" for the network former, silica, might be expected to decrease the bond strength of the glass structure with a consequent decrease in the glass hardness. The results showed that relatively high amounts of modifiers such as sodium oxide, barium oxide, etc., could be substituted in this particular glass without markedly altering its hardness. This indicates that the Knoop hardness is dependent upon other factors in addition to the "strength" of the glass structure, the most important of which is probably the "packing" of the glass structure. A low coefficient of ex-

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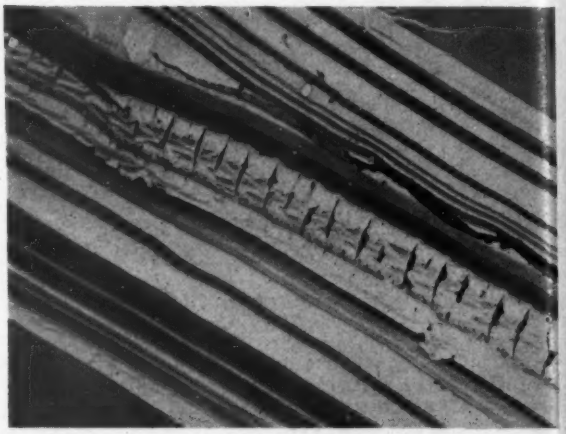


Fig. 1 represents one of the scratched surfaces.

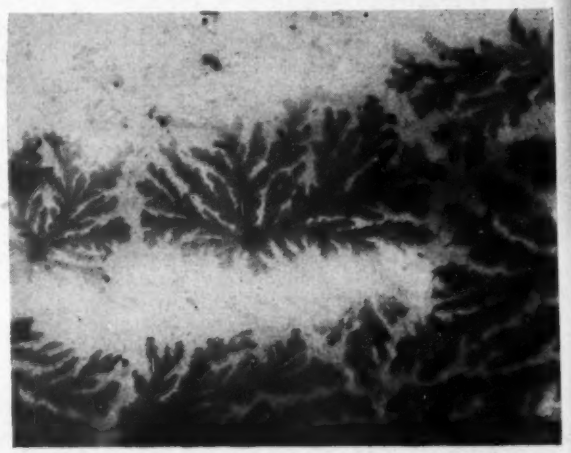


Fig. 2 represents a surface from a "dimming" test.

Ceramic Camera Club

"Into the Future" by Hobart M. Kraner
Chauncey E. Frazier Award

Prize Winners 1946

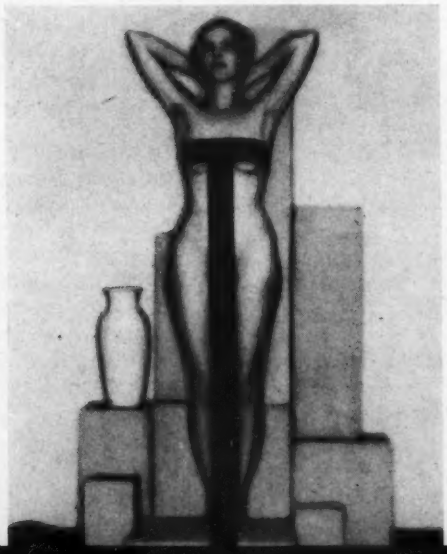
"David" by V. H. Remington
Honorable Mention, Portrait

"Out of the Fog" by Fred Peel
First Prize, Industrial & Scientific

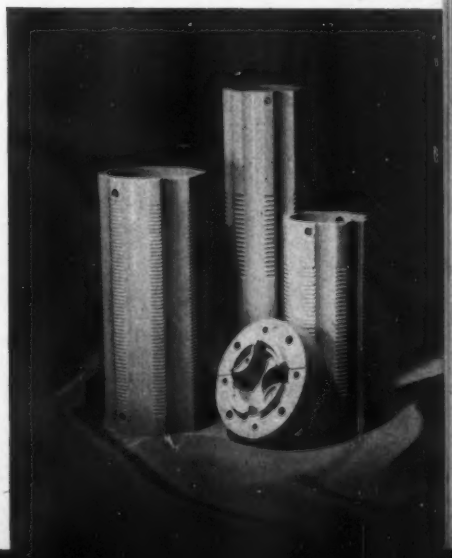
"Narcissus" by Rolland Roup
F. J. Vontury Award. First Prize, Pictorial

"Lady in White" by Fred Peel
First Prize, Portrait

"Vase and the Maid" by Fred Peel
Honorable Mention, Pictorial



"Art Ware in Industry" by Rolland Roup
Honorable Mention, Industrial & Scientific



ELECTRICAL ANALOGY METHOD FOR INVESTIGATION OF TRANSIENT HEAT FLOW PROBLEMS

During the recent Buffalo meeting of the Glass Division of the American Ceramic Society, it was brought out that much success was being achieved in the solving of heat flow problems by a new method known as the electrical analogy method. A discussion of this method by its developer, Dr. Victor Paschkis, was presented a few years ago in the November 1942 issue of *Industrial Heating*. In order to acquaint the glass industry with this method and its possibilities as a tool for solving some of the industry's problems, a summary of this discussion follows:

Transient heat flow problems enter into a great number of industrial processes. Yet, there is hardly another field of technical endeavor left more to guess-work than that of temperature and heat flow under conditions of unsteady state.

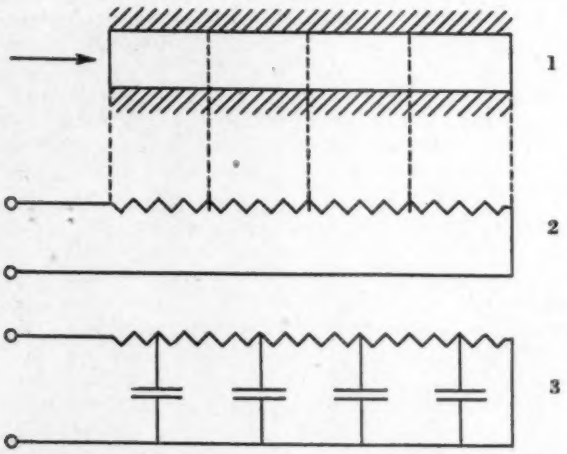


Fig. 1. Diagrammatic representation of a rod subjected to axial heat flow. The rod is thought of as being cut in sections.

Fig. 2. Electric circuit representing the problem of Fig. 1 for steady state conditions. Each section is represented by one resistor.

Fig. 3. Electric circuit representing the problem of Fig. 2 for transient conditions. Each section is represented by one resistor and one condenser.

In the majority of applications, temperatures change with time. "Unsteady" state prevails. However, due to the difficulties of rational solution, it is customary to deal with unsteady state problems as if a steady state existed. Such an approximation affects the selection, design and operation of equipment. Waste of time and money often result.

Heat specialists generally recognize that the reason for this state of affairs lies in the difficulty of obtaining accurate data on unsteady state heat conditions. In the past, only two methods of analysis have been available, i.e., direct experimentation and mathematical analysis. Direct experimentation is in most cases very costly and takes much time. Of all measuring techniques, that of temperature is one of the most difficult. Measurement of actual heat quantities is a field hardly developed as yet. The results of many heat flow problems are influenced by a large number of independent factors. In experimentation, it is frequently difficult to separate the influence of these individual factors.

Mathematical solution is possible only for a very few cases and, even then, can be done only on the basis of simplifying assumptions more or less justified. Even if the type of solution is known, the numerical evaluation is frequently impractical.

Therefore, a new electrical method, which has been developed in the School of Engineering, Columbia University, should be of interest. The method is based on the analogy between the flow of heat in a solid and certain electric circuits.

For steady state, the analogy is well known: electric voltage is analogous to temperature; electric current to heat flow (Btu/hr); and electric resistance to thermal resistance (the inverse of thermal conductivity). Based on this analogy, a heat flow in steady state, say through a rod (Fig. 1), can be represented by and calculated from an electric circuit (Fig. 2). The rod is insulated on its sides so that the heat flow is entirely parallel to its axis. If the rod is composed of two materials of different conductivity (or different resistance), two different electrical resistors are to be applied.

The possibility of representing the heat flow by the electric flow is evident from the identity of the equations governing the two phenomena: Let r_e = the electric resistance, r_h = the heat resistance, i = the electric current, q = the heat current, E = the electric voltage, and T = the temperature difference. Then, we can write:

$$E = i \times r_e \quad (1)$$

and

$$T = q \times r_h \quad (2)$$

If the unsteady state is considered (in which the temperatures at each point are a function of time), only one item has to be added to the list of analogies: electric capacity may be considered to represent the thermal capacity (specific heat per unit volume x volume). The correctness of this analogy is evident from the identity of the underlying differential equations.

$$\frac{dT}{dT} \times a \frac{d^2T}{dx^2} \quad (3)$$

$$\frac{dE}{dT} = \frac{1}{cr} \times \frac{d^2e}{dy^2} \quad (4)$$

In this equation, a diffusivity, T denotes time, c denotes electric capacity, r denotes electric resistance and y denotes length of path.

In order to represent the transient heat flow, say in heating up the rod (Fig. 1) from one side, it is only necessary to add capacitors to the circuit shown in Fig. 2; a circuit as shown in Fig. 3 results. The diagrams show that in order to represent a body which is subjected to heat flow, it is considered as divided into sections. In electrical terms, the circuit is "lumped". Figs. 2 and 3

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BAUSCH & LOMB ACHIEVED ENORMOUS OPTICAL PRODUCTION IN WARTIME

By LEO J. SULLIVAN
Rochester Gas & Electric Corp., Rochester, New York

World War II was, among other things, an optical war.

Victory for our Armed Forces depended as certainly upon the availability and quality of optical glass as it did on gasoline, rubber and essential metals.

The biggest block-busters, the most destructive shells would be ineffective if they failed to find their targets. Only the highest quality optical glass made accurate shooting and bombing possible and without this vital and strategic material, our Army, Navy and Air Force would have been powerless and the United States would have been unable to fight a modern mechanized war.

Removing a pot of molten optical glass from the furnace.

In World War II, there was never a serious problem in optical glass production. Bausch & Lomb Optical Company of Rochester, New York, produced enough for its own needs and contributed to the requirements of other optical manufacturers. It helped establish other sources of supply as further insurance against any eventuality. Since World War I, the Bausch & Lomb glass plant has been producing optical glass continuously as a pledge to America—a pledge that never again would we have to depend on foreign sources for this vital war material. Without government subsidy, it absorbed the higher production costs and continued to produce and perfect its own optical glass.

Today, Bausch & Lomb, entirely in the United States, manufactures 112 different kinds of optical glass—glass which affords a wide variety of optical and physical properties.

Production demands far exceeded pre-war military estimates and, through construction of additional furnaces, by utilization of capacity to the very limit and by improved and speedier methods, Bausch & Lomb is able to meet every requirement.

The technique of optical glass production is a most exacting process that has been built up over a period of thirty years by constant research and development. However, we can briefly summarize the major production operations.

The clay pot, a heavy cylindrical vessel open at the top and measuring 30 to 42 inches in diameter, is cast from high grade clays. It is air dried for three months and then slowly heated from room temperature to 1800°F. over a period of five days.

This is a critical operation in the life of a clay pot. The small amount of residual moisture must be carefully driven off by raising the temperature of the furnace very slowly during the first few hours of the heating cycle followed by uniform increment rise in temperature during the balance of the five-day heating period.

This pot preheating is done in fifteen semi-muffle furnaces, or so-called pot arches. Each pot arch holds from one to three clay pots and is loaded from the front. Atmospheric air mixers with low pressure gas and open end burners are distributed along each side wall. Combustion takes place under the hearth slab and is completed before the hot gases are discharged along the opposite side of the hearth. The hot gases then flow upward and are vented to the atmosphere through the openings in the crown of the furnace. Manufactured gas is supplied to the mixer orifices at approximately eight inches water column and atmospheric air is drawn in at the mixer and around the burner. This produces soft, long flames well distributed throughout the length of furnace and materially helps to produce uniformity of heating and ease of control of temperature. At the start of the heating cycle, only the pilot burners are used to slowly raise the temperature during the danger period when pots could

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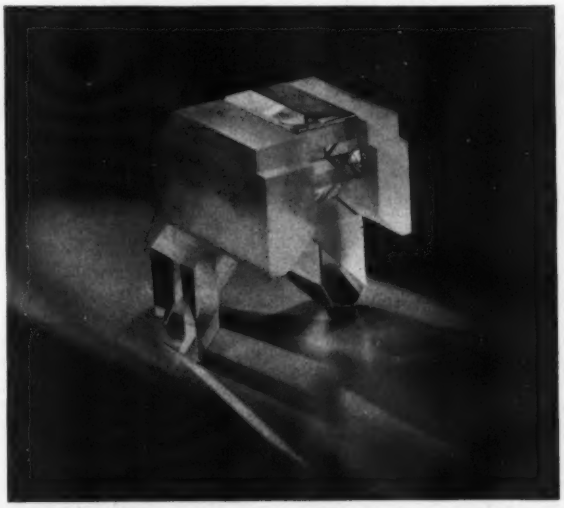

Optical glass fulfills its ultimate destiny in scientific and military optical instruments of extreme precision and infinite variety. This range finder prism is notable alike for its complexity and precision.

FLAT GLASS INDUSTRY FILES ANSWER TO ANTI-TRUST SUIT

All allegations of the government's anti-trust suit that "since 1935, the flat glass industry in the United States has been controlled and completely dominated by Pittsburgh Plate Glass Company and Libbey-Owens-Ford Glass Company" were denied by these companies and several other defendants in an answer filed in the Federal District Court in Toledo on May 18. The civil suit was filed in Toledo May 23, 1945 by Curtis Shears, special assistant to the Attorney General, in Federal District Court.

In addition to the above named companies, defendants included among the nine corporations, an association of glass distributors, and a number of officers of companies and associations are: Fourco Glass Company, Rolland Glass Company, Eugene Rolland, W. M. B. Sine, Corning Glass Works, Amory Houghton, American Window Glass Company, Blue Ridge Glass Corporation, Franklin Glass Corporation, American Securit Company and the National Glass Distributors Association.

After a hearing before Judge Frank L. Kloeb in the Federal Court on February 19, the government filed an amended complaint and bill of particulars on March 19, as ordered by the court.

Defendants contend in their answer to the government suit that an industrial revolution creating continuous machine production methods for making both plate and window glass came about in the last two decades making plants obsolete, improving quality of product, reducing unit costs, and that the large-scale requirement of the automotive industry could be served only by large integrated glass manufacturing companies.

It is also contended that trade practices relative to pricing go back to the beginning of the industry; foreign investments were of minority character; certain patent transactions cited by the government were made to settle infringement claims in the early development of safety glass, the glass companies declare.

The complaint charges violations of the Sherman Anti-Trust Act, Wilson Tariff Act, and Clayton Act in respect of foreign and domestic licenses and transactions, and in regard to marketing and distributing practices.

The government in its complaint asks the court to dismember all of the larger companies with plants in important glass-producing areas now integrated into economical producing groups and asks for complete wiping out of some defendants.

The answer filed denies all government contentions relative to control of the industry and fixation of production quotas, citing in detail production and shipment figures for both plate and window glass from 1928 through 1945. Wide variations are shown from year to year in the output and shipments of plate and window glass by the various defendant companies.

The window glass makers maintain that much of the change in their industry whereby small companies disappeared from business and larger units developed was due to revolutionary advances involving new types of glass tanks, machines and methods of handling glass.

It is stated in the court document by the window glass defendants that "window glass had been handblown in America since early Colonial days; that there had been little change in the method of production or in the equipment used up to 1880; that improvements were made during the next two decades; that the increased use of gas as a fuel and the adoption of the tank furnace to replace the pot furnace made possible larger production and more continuous operation; and that competition with imported glass was active."

It was admitted that there were 100 or more window glass companies in the United States before and in 1900, most of which were located in Indiana, Pennsylvania, Ohio and West Virginia, and that "the window glass industry has been a precarious business involving great risk of loss as a result of wide changes in the supply and demand of window glass from time to time, changes in manufacturing methods and technological improvements which effected an industrial revolution, and other causes beyond the window glass manufacturers' control."

Likewise, it is stated that plate glass underwent vast changes in manufacture from the first successful plant in America established by John B. Ford in 1870 at New Albany, Ind., up to very recent times when continuous machine methods have been used for rolling plate glass blanks.

Revolutionary changes began to take place in 1921, the glass companies' answer sets forth. The old style table casting process of making plate glass blanks was "gradually replaced by various continuous tank processes developed by Ford Motor Co., Pilkington Brothers, Pittsburgh Plate Glass Co., and Libbey-Owens-Ford Glass Co., respectively, and by intermittent pot-casting roller processes independently developed by Bicheroux and Pittsburgh Plate Glass Co." It was also cited that continuous methods of grinding and polishing plate glass blanks were developed by Ford Motor Co., Charles Houze of Belgium, Pittsburgh Plate and Libbey-Owens-Ford.

In summarizing the effect of these changes in manufacturing methods, the defendant companies state, "The advent and commercial development of these revolutionary processes made obsolete large existing plant investments, improved the quality of plate glass, tended to reduce the unit costs of production, mechanized the industry, made possible larger scale production, more continuous operation and led to the formation of large-scale manufacturing units, adequate to serve large-scale consumption particularly the automotive industry."

Several of the automotive companies went into the plate glass business when closed car models became popular after World War I. There was a tremendous impetus given to plate glass production by these automotive requirements. However, in time all the motor car makers except Ford Motor Company ceased making their own glass and bought their requirements from the plate glass companies.

Covering marketing operations the answer to the government suit outlines how the products are marketed largely through jobbers who maintain sales and service

(*Continued on page* 310)

CONTAINER GLASS OF HIGH ALUMINA CONTENT

EDITOR'S NOTE: During the war years, copies of German technical publications were, of course, unavailable in the United States. On the theory that American glass technologists may have been deprived of useful technical information, *The Glass Industry* requested the Department of Commerce to secure complete volumes of *Glastechnische Berichte* for the purpose of translating and abstracting any important papers which may have been published during the war period. We are pleased to announce to our readers that through the cooperation of the Office of the Publication Board of the Department of Commerce, complete volumes for the years of 1940-1943, inclusive, have been made available. Starting with this article, readers can look forward to a series of translated digests of what are considered to be the most important papers which have appeared in the German publication during the above period.

In 1927 the "Muhlig Union Glass Industry A.G." in Czechoslovakia began to explore the possibility of using an alkali bearing rock as the major constituent of their bottle glass batches. They had available a phonolite, mined in Sellnitz near Bilin of the following composition:

SiO_2	55.2	CaO	0.7
Al_2O_3	33.2	MgO	0.5
Fe_2O_3	2.0	Alkali	14.9
MnO	0.3	Loss on ignition	3.0

The use of such a material containing nearly 15% alkali was very desirable, because it replaced soda ash and sodium sulfate, the most expensive constituents of the glass batches. The iron and manganese content of this natural raw material was of no concern, because the glasses were of the green and brown Owens type. The only limiting factor seemed to be the relatively high alumina content.

The German type of Owens Glass is characterized by a lower alkali content than the American types. No. 1 and 2 in Table I are representative compositions of German green Owens Glasses taken from the two leading container companies. The alkali content varies between 12 and 15%, its alumina is between 6 and 8%. It has a high chemical resistivity, good strength properties and its thermal properties make it well suited for pasteurizing.

TABLE I

	1	2	3	4	5	6
SiO_2 .....in %	65.44	64.08	54.34	57.48	58.74	58.26
Al_2O_3 ..... "	6.72	6.44	17.20	15.26	14.17	14.77
Fe_2O_3 ..... "	2.46	1.92	1.92	1.84	1.95	1.95
MnO ..... "	0.80	0.43	0.46	0.42	0.20	0.18
CaO ..... "	11.39	11.29	12.77	11.35	10.79	10.86
MgO ..... "	0.95	0.58	0.51	0.55	0.99	0.91
Alkali ..... "	11.89	14.93	12.37	12.47	12.62	12.53
SO_3 ..... "	0.28	0.37	0.45	0.78	0.61	0.59
Standard test .... mg.	9.0	12.0	....	5.4	5.8	5.3
Acid test ..... mg.	14.0	16.0	....	68.0	49.0	64.0

There was a widespread opinion among German container-glass manufacturers, that the use of natural alkali bearing rocks is limited by the alumina content of their glass. Higher alumina content, it was pointed out, was expected to increase the melting difficulties and thus upset the savings made by decreasing the soda ash.

The experiments in the "Muhling Union Glass Industry A.G." seemed to prove, however, that this opinion was not justified. Raising the alumina content above the normal level did not result in higher melting temperature. If only care was taken that the new melting charge was brought in contact with the hot molten glass, the normal melting temperature of 1450-1460°C remained perfectly satisfactory. Before putting in a new charge, the melter had to push the half molten batch pile towards the middle of the tank, so that the new pile came in contact with the hot fluid metal. The fuel consumption remained the same and so did the homogeneity of the glass. The working properties did not undergo major changes, but it was found necessary to raise slightly the temperature of the revolving part of the glass tank. The chemical resistivity, as measured by the German Standard Powder Method, was normally excellent and improved even further.

Within a period of three months the phonolitic additions were increased until the final glass had reached an alumina content of 17%. During this change the milling facilities for the phonolite proved to be inadequate so that occasionally the rock had to be introduced in a grain size of 6 mm. Even these coarse grains did not cause melting difficulties or defects. In order to get experience with the new high alumina glass its composition (No. 3 in Table I) was left unchanged for the whole year of 1928.

Several million pieces of the high alumina container glass were sold without objections from the customers, when accidentally it was discovered that the glass with the 17% alumina was rather sensitive to attack by acids.

This phenomenon was studied scientifically. For measuring the acid resistivity of the glass powder, the Standard Powder Method as adopted by the German Glastechnische Geselleschaft had to be modified. (*Glastechn. Ber. 6* (1928-29) page 635.) Instead of distilled water, the same volume of a 5% HCl was used. The quantity of the glass powder was decreased from 10 g to 5 g.

The investigation of the acid resistivity of the modified glasses led to the following conclusions.

The glass containing about 12.13% alkali had to contain at least 56% SiO_2. Glasses with lower silica content were found objectionable. In order to meet this condition and at the same time keep the alumina content at 17%, the percentage of lime had to be lowered 2% below the normal level that in turn leads to melting and fining difficulties. As a compromise between decreased acid resistivity and maximum utilization of phonolite, glass compositions were developed whose alumina content were around 15%. Nos. 4, 5 and 6 in Table I are representative analyses of the Muhlig Union glasses from June 1931, April 1937 and June 1943.

In a following communication (*Glastechn. Ber. 21* (1943) 260) W. Konig discussed his experiences with the development of brown container glasses of the Owens type using phonolite as the major batch ingredient.

There are two principally different ways to produce brown bottle glasses. In England and in the U.S.A.

(*Continued on page* 318)

PLASTIC BANDS AND SLABS REINFORCED WITH GLASS FIBERS

The valuable mechanical qualities of glass fibers bonded with plastics have attracted the attention also of Russian technologists. A. K. Burov (with five collaborators) studied some of these glass-plastics combinations on laboratory scale and presented a report (in *Russian Journal of Technical Physics 15*, 407, 425. 1945) the main features of which are as follows:

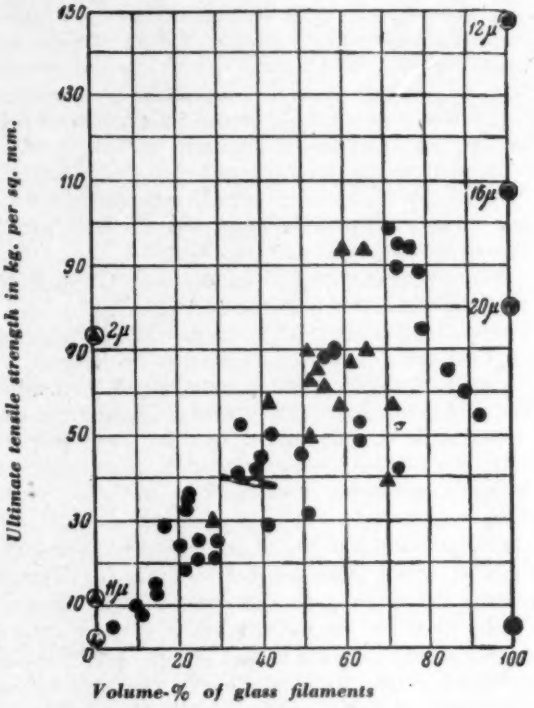

Fig. 1—Ultimate tensile strength of glass-plastics bands of different glass contents.

The breaking stress of single glass fibers increases linearly with 1/d, d being the diameter of the fibers, within the whole range investigated by Burov. For instance, filaments having $d = 26.10^{-4}$ cm. (0.0010 in.) broke at 80 kg. per sq. mm. (about 110,000 lbs. per sq. in.), and those with $d = 8.10^{-4}$ cm. (0.0003 in.) at 210 kg. per sq. mm. (about 290,000 lbs. per sq. in.)

This high strength is only very incompletely utilized in glass yarns and glass fabrics. A woven glass tape, for instance, has the ultimate tensile strength of 10-20 kg. per sq. mm. of the glass in it; it is seen that 9/10 of the original strength are lost in spinning and weaving. The object of Burov's work was to find whether a better utilization of the strength of individual filaments could be achieved by bonding them by means of an adhesive.

The glass used had the composition SiO_2 72.16, Na_2O 17.23, CaO 9.26, MgO 0.32, and B_2O_3 0.97 per cent. It has been kept at 1200°C (2192°F) in a platinum crucible provided with orifices through which the filaments were drawn. When the orifice diameter was 1.5 mm. (0.06 in.) and the speed of filament 360 cm./sec. (almost 12 ft. per sec.), filaments 12.10^{-4} cm. (0.0005 in.) thick have been obtained.

The filaments have been wound on a rotating drum and at the same time sprayed with a plastic solution. After the plastics substance had set, the "sleeve" formed on the drum had been cut length-wise. That gave bands, 90 cm. (almost 3 ft.) long and 25 cm. (almost 10 in.) wide. The mechanical strength, chemical endurance, shaping ability, etc of these bands have been determined.

Among the binders tested urea-formaldehyde and phenol-formaldehyde resins proved to be too brittle, although plasticized urea-formaldehyde was satisfactory. Acrylic resins did not adhere well to glass. Asphalt and bitumen had no ductility (that is broke at a very small total elongation), and water displaced them from the glass surface. Revertex (a processed rubber latex) gave only weak bands. Addition of sulfur to the latex reduced its adhesion to glass. The few tests performed using cellulose nitrate and cellulose acetate showed some promise. The major part of the work has been carried out with gelatin, casein, alkyd resins, and a vinylic resin obtained as a by-product of synthetic rubber. Gelatin has been sprayed as a 10 per cent aqueous solution at 80°C (176°F).

Table I lists the breaking stress (in kg. per sq. mm.) for two kinds of bands containing a "high" and a "medium" proportion of glass fibers. The specimens used for rupture tests were 19 ± 1 cm. (about 8 in.) long, 1.0 ± 0.05 cm. (0.4 in.) wide, and 0.10-0.15 mm. (0.04-0.06 in.) thick. Apparently they have been belasted only parallel to the direction of the fibers; no information is given on the strength in the other directions.

The uniformity of the bands was satisfactory. For instance, nine samples cut out of one band (containing 42 per cent of gelatin and 58 per cent of glass filaments) had ultimate tensile strengths varying from 67 to 76 kg. per sq. mm., that is, within ± 6 per cent of the mean value. Seven samples cut from a band containing 22 percent of glyptal resin and 78 per cent of glass filaments gave strength values between 87.4 and 103.3 kg.

TABLE I

ULTIMATE TENSILE STRENGTH OF GLASS-PLASTICS BANDS

Binder	*Percentage of glass*	*Ultimate tensile strength (kg. per sq. mm.)*
Gelatin	70-88	60-98
Gelatin	50-60	45-70
Vinylic resin	60-65	58-93
Vinylic resin	50	50-70
Glyptal resin	75-77	95-102
Glyptal resin	66	79
Urea-formaldehyde	91	80
Urea-formaldehyde	54	42
Casein	78	73
Casein	50	29
Bitumen	52	42

(*Continued on page* 316)

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Feeding and Forming

Patent No. 2,399,825 is an invention of Frank W. Preston of Butler, Pa. The original application for this patent was divided and Patent No. 2,342,218 was issued February 22, 1944.

The patent discloses a novel method of forming flat glass sheets into corrugated sheets of uniform thickness. It is a well known fact that when a flat sheet is placed on a corrugated table and then rolled to make it conform to the shape of the table, stretching occurs which produces thin spots in the finished sheet. Also, this stretching causes a drag between the glass and the forming tools which is injurious to the surface appearance. As reinforced wire glass cannot be stretched, it cannot be reheated and rolled into corrugations by the usual methods.

A side view of the machine for carrying out the Preston method is shown in Fig. 1. A base 7 has ways to permit a cradle 9 to be reciprocated through a rack 10 and a gear 16 which is driven by a reversible motor. The cradle carries a table 11 having a forming surface 47 of the shape to be imparted to the glass. A crimping roll 39 cooperates with the table to shape the glass. The roll is mounted in the end of a rocker arm 34 pivotally mounted on a shaft 35 and carrying rollers 41 supported by cam tracks 42 fixed on the cradle 9. By this construction, the crimping roll 39 is raised and lowered to correspond with the contour of the table 11. In order to maintain the desired relative speeds between the roll 39 and the table 11, the cradle 9 carries a cam track 24 which acts upon a roll 23 mounted on a spring pressed casing 18. The relation between the cam tracks 42 and 24 are such that every time the roll 39 is raised or lowered, the casing 18 will be tilted by the cam track 24 to vary the speed of the roll 39. By this construction, a sheet of glass can be formed between the roll and table without any stretching of any part of the sheet.

The hot sheet 50 to be shaped is placed on an inclined table 57 down which the sheet slides by gravity. The lower edge of the sheet engages a stop 52 and as the table 11 moves to the right in the figure, the sheet slides down to rest upon the table at a rate determined by the contour of the table. As no stretching occurs, this permits the shaping of a wire reinforced sheet.

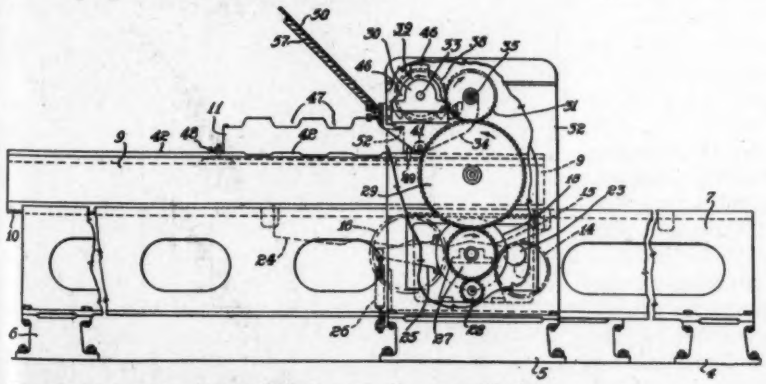

Fig. 1 Patent No. 2,399,825. Preston Forming Machine.

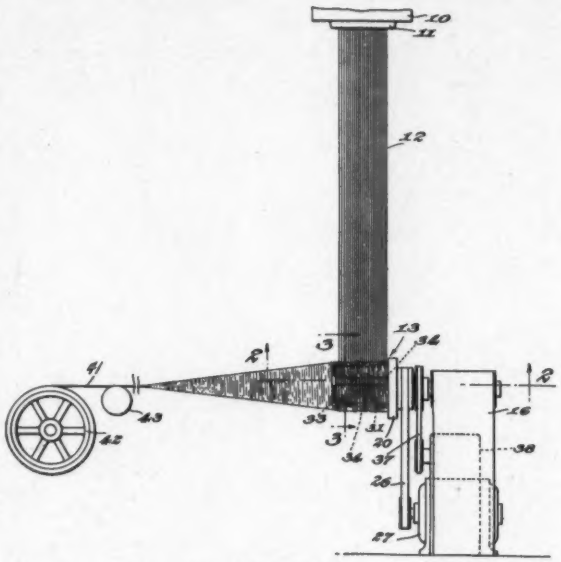

Fig. 2. Patent No. 2,398,808. Owens-Corning Fiber Machine.

Glass Wool and Fiber

Patent No. 2,398,808 is on a glass fiber forming machine assigned to Owens-Corning Fiberglas Corporation by the inventors, Games Slayter and Ed Fletcher. While the invention is particularly adapted for forming fibers from glass, it may also be used with cotton, silk, wool and certain plastics. This patent is an improvement over the device shown in Re-issue Pat. No. 22,078 to Newman and Romig in which fibers are collected on a rotating body and then drawn off one end of the body.

Fig. 2 shows a general view of the invention. Molten glass flows in a plurality of small streams 12 from a container 10. These streams are attenuated by a rotating cage 13 containing a cylinder 31 having a multiple screw thread on its surface. The construction is such that the fibers extending from one of the bars 34 to another are engaged by the threads on the cylinder 31 and urged to the left in the figure and off from the cage 13. The bars 34 of the cage are tapered slightly to facilitate this movement.

Driving means mounted in a base 16 are provided to rotate the cage at a high speed in order to attenuate the streams 12, and the cylinder 31 is rotated at a slower speed in the same direction to provide the desired axial travel of the fibers off the end of the cage to form a strand 41. A Reece-type roll 43 is provided to traverse the strand along a packing spool 42. It is recommended that the strand be treated with a lubrication and binding material before it is wound on the spool.

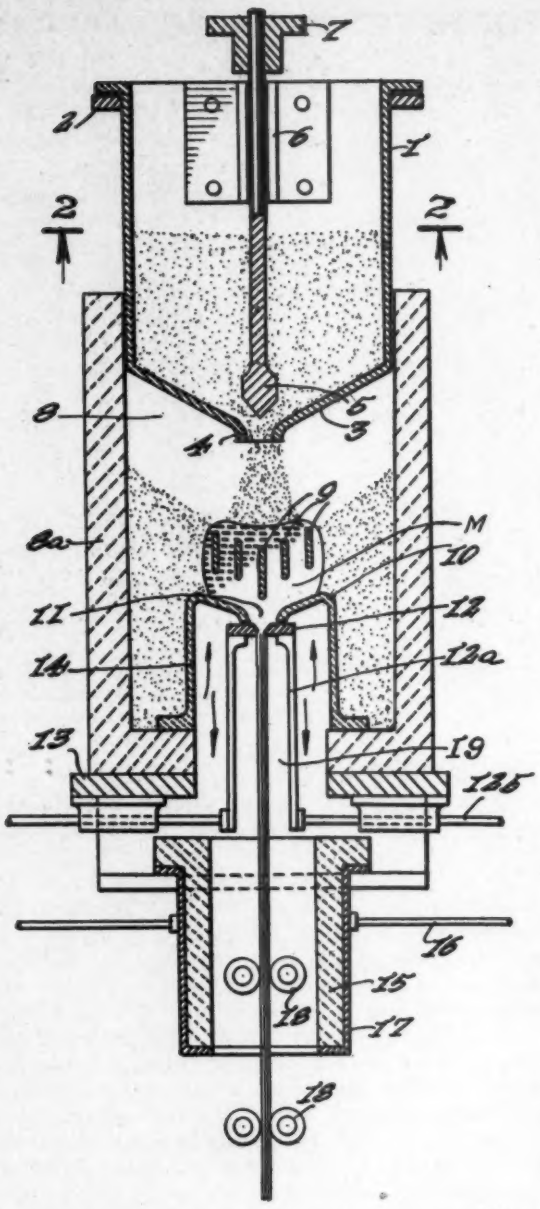

Fig. 3. Patent No. 2,398,952. Apparatus for Making Silica Glass.

Miscellaneous Processes

Patent No. 2,398,952 on an apparatus for making silica glass was issued to Henry J. Nachod. This patent is a continuation of another application filed May 17, 1940 which has not yet been issued.

The methods previously employed for this purpose were expensive both in operation and in the necessary raw material. Also, only small articles could be made due to the high temperature (about 2,000°C.) which was necessarily maintained in a large body of molten silica.

This invention is said to provide a continuous melting process, preferably electric, which overcomes the difficulties encountered. This is done by preventing the inclusion of air, gas or moisture in the material to be melted, applying sufficient heat to melt the individual grains of sand very quickly and preventing the evaporation of silica so far as possible.

As shown in Fig. 3, sand is delivered from a container 1 at a rate determined by a valve 5 to a chamber 8. An electric heater 9 is positioned so as to receive the sand and to melt the individual grains so as to form a small pool M of molten silica which is surrounded by sand provided when starting. The molten silica descends through a slot 11 formed between adjustable plates 12. Rods 12b are provided to adjust the plates 12.

By a proper ratio between the rate of feeding the sand and the rate of withdrawing the molten product, a continuous process is obtained. The preheating of the sand changes the alpha-quartz to beta-quartz or possibly to gamma-quartz.

Patent No. 2,399,770 is on a process of sealing glass to metal invented by Raymond L. Taylor and assigned to Bell Telephone Laboratories. The invention is particularly useful in the manufacture of electrolytic condensers and electron discharge devices.

It is known that in order to form a satisfactory seal between glass and metal, the surface of the metal must have a film of oxide which will dissolve in the hot glass and act as a cement. It has been difficult to accomplish this with tantalum and zirconium. However, the present

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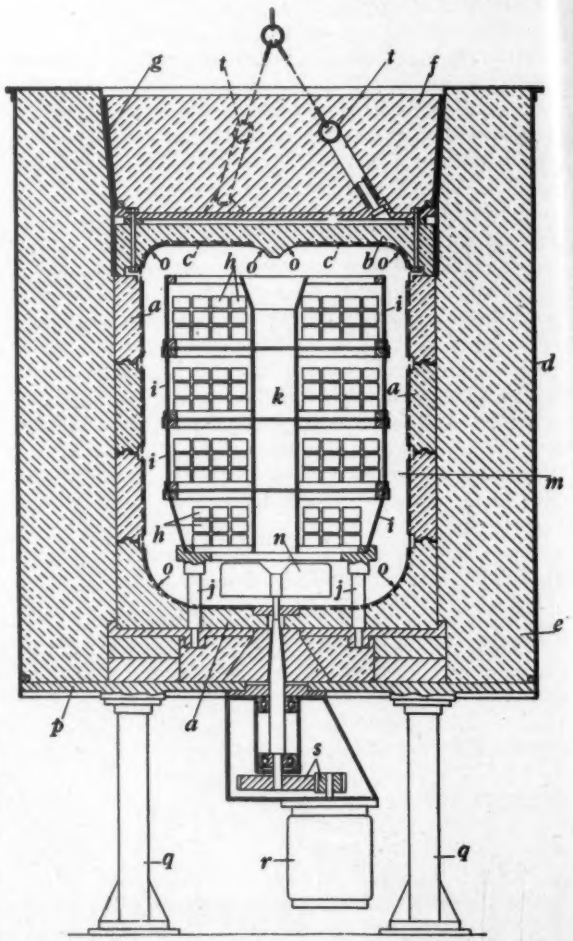


Fig. 4. Patent No. 2,400,056. Annealing Kiln for Optical Glass.

COURT APPROVES PURCHASE OF KIMBLE GLASS BY O-I

Judge Frank L. Kloeb, of Federal District Court in Toledo, has approved the acquisition by the Owens-Illinois Glass Company of the business and assets of the Kimble Glass Company.

Kimble Glass Company has plants located at Vineland, Pleasantville and Camden, New Jersey, Chicago Heights, Illinois, Indianapolis, Indiana, and Conshohocken, Pa., and is engaged primarily in the manufacture of tubing and cane and the fabrication of products therefrom. Owens-Illinois has not heretofore been engaged in this field.

Wm. E. Levis, Chairman of the Board of Owens-Illinois Glass Company, announced it is contemplated that the shares of Owens-Illinois Glass Company will be used in the purchase of the assets. He further stated that the acquisition is subject to the approval of the directors of the two companies and the shareholders of Kimble Glass Company.

Operation of Kimble Glass Company will be continued under its existing management as a wholly owned subsidiary of Owens-Illinois and, according to the announcement, it is contemplated that the business will be expanded into other fields in which they have not previously been engaged.

GLASS CONTAINER MEETING POSTPONED

The Annual Meeting of the Glass Container Manufacturers Institute, which was scheduled to be held at the Hotel Hershey in Hershey, Pa., May 13, 14 and 15, was postponed only a few days prior to the meeting due to the protracted soft coal strike.

In cancelling the meeting, it was pointed out that while transportation was a factor in the Institute's decision to postpone the meeting, more serious considerations were the threatened lack of supplies and power. Container glass furnaces must run on a twenty-four hour basis. If the glass cannot be kept in a proper state of viscosity, tanks must be drained in which event two or three weeks would be required before the tank was again in production.

It was the possibility of plant shutdown that kept the glassmen at their desks. It is hoped that a meeting can be arranged at a later date.

DU PONT BOARD ANNOUNCES RECENT ELECTIONS

Following a meeting of the Board of Directors of the E. I. du Pont de Nemours & Co., Inc., it was announced that Dr. Crawford H. Greenwalt has been named to succeed the retiring Jasper E. Crane as a vice president and member of the company's Executive Committee. At the same time, Dr. Greenwalt, who is already a director of the company, was elected a Vice President.

The selection of Walter J. Beadle as Vice President and Treasurer of the company to succeed James B. Eliason, also retiring, was simultaneously announced. Mr. Beadle was also elected a member of the Board.

Both Mr. Crane and Mr. Eliason will continue as members of the Board of Directors. Mr. Eliason will retain his membership on the Finance Committee.

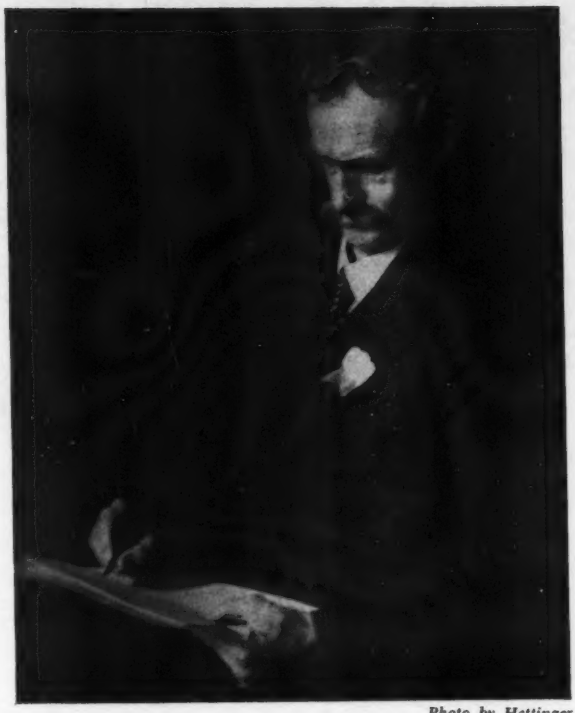


Photo by Hettinger

W. E. S. TURNER

SOCIETY OF GLASS TECHNOLOGY HOLDS ANNUAL MEETING—PROF. TURNER RETIRES

The report of the Council for the year 1945, presented at the Annual General Meeting of the Society of Glass Technology held at Sheffield, England, April 25, stated that in addition to the meetings and activities of the parent body, are an Indian Section and five Local Sections in operation. Total membership exceeded one thousand, distributed through thirty-five countries.

Professor H. Moore, D. Sc., A. R. C. S., retired from the Presidency, after holding office for two years, and was succeeded by Mr. Geoffrey I. C. Marchand, M. A., Director of the Glass Manufacturers' Federation. Professor W. E. S. Turner, O. B. E., F. R. S., Honorary General Secretary, will retire on May 31st, and Dr. J. H. Partridge, of the Research Laboratories of the General Electric Co. Ltd., Wembley, will be his successor. Mr. F. G. Orme, O. B. E., relinquished the office of General Treasurer, and Mr. A. E. Hill, B. Sc., was appointed in his stead as from August 1st. From April 25th until July 31st, Mr. C. E. Ramsden, a member of Council, will serve as acting-Treasurer. Mr. F. C. Flint remains in office as American Treasurer.

Professor Turner, the founder of the Society, who has exercised a profound influence on its development for a period of thirty years, will continue to act as Editor of its Journal. As President of the International Commission on Glass Technology, he will be able to continue to give his help in a wide sphere.

• A $375,000 expansion of the Liberty Glass Company that will raise the total monthly production to more than 9,000,000 milk bottles has been announced by company officials. The new building will cover about 25,000 square feet and house a 60-ton furnace.

BROKEN GLASS AIDED THE ENEMY

Editor,

THE GLASS INDUSTRY

I am sending you this letter in order to bring up a point which I think might be of interest to glass container manufacturers.

During the European campaign, I was working with the Counter Intelligence Corps. At one point, my outfit was called in to investigate the Luftwaffe bombing of one of our important installations. This installation had been built secretly, all measures for security having been taken. It was hidden in a small forest and all telltale traffic tracks leading to it had been erased. Why had this particular forest been selected as a target for bombing? A thorough investigation left us baffled. The case had to be left unsolved.

Some time later, our troops overran a small German airfield and we were called in to interrogate captured enemy flyers.

When questioned about his last missions, one of the airmen mentioned that he had taken part in the raid on the forest. So, our case was open again! After thorough interrogation and a close check of Luftwaffe Intelligence Photographic Files found in the hangers, we had our answer. Air observation pictures taken at night with the aid of flares had shown all kinds of shiny reflections at the edge of the forest. These marks, upon close scrutiny, were revealed to be broken glass from food containers thereby showing evidence of an allied installation inside the forest. Thus had a safely guarded installation been bombed and put out of use for a considerable period of time because of a few pieces of broken glass reflecting light.

It seems to me that this is a matter glass technologists would do well to look into. Some of the glass containers found in the forest area were painted on the outside, but once broken, the inside proved to form a perfect beacon.

Is there no way that such a danger might be overcome by applying a non-injurious coating to the inside of the container which would eliminate light reflection?

Returned Veteran.

INDUCTION FURNACE FAILURE HALTED BY FIBERGLAS CORDAGE

Production losses resulting from failure of induction furnaces employed for the melting of copper in the manufacture of shell cases at the U. S. Naval Gun Factory in Washington, D. C., have practically been eliminated by the use of Fiberglas cord.

Four induction furnaces were used at the factory and work records reveal that one primary coil would burn out on the average of once a month. Mica flakes used to insulate the one-eighth-inch space between conductors would powder out under vibration and other service conditions. Spauling-off of the ceramic mud over the coil assembly would result in loss of the mica flakes.

This condition created a short between the conductors and took the furnace out of production. Because the furnace cooled immediately, the ceramic lining in the furnace proper was damaged and it was necessary to reline the entire furnace. Furnace relining cost $3500 per year, aside from the production loss incurred.

Experiments finally proved that Fiberglas cord EC5-8 was the most satisfactory inorganic tape or cord applied, Twelve turns of the cord were applied between the conductors. Sodium silicate, which is resistant to high temperatures, was applied over the cord and allowed to dry. The assembly was sheathed with ceramic mud. Coils insulated with Fiberglas cord have been in operation as long as 18 months without failure.

PART OF CZECH GLASS INDUSTRY NATIONALIZED

Enterprises of the Czechoslovakian glass industry producing more than 1000 liters per day were nationalized by decree October 27, 1945. The low figure of the limit indicates the importance of the glass industry in the national economy of Czechoslovakia. As a consequence of this limit, all but artisan type enterprises will form a part of the nationalized glass industry for which Mr. Lausman, Secretary of Industry, has recently appointed a general manager, two deputy managers and a Central Committee consisting of nine members and nine deputy members.

The general manager, Josef Hrnicko, is an administrative officer of the largest and best known Czechoslovakian glass company, Inwald. Of the 18 members of the Committee, 7 are employees of central industrial organizations such as the Manufacturers' Association, the Export Cartel and the Council of Industry, 2 are prominent leaders of the Glass Workers' Union, 1 a representative of the Office Employees' Union, 2 Industrialists, 2 Technologists, 3 Foremen or Office Employees, 1 Company Lawyer and 1 Workman.

Dr. Vaclav Ctyroky, Director of the Glass Institute in Hradec Kralove, was appointed a member of the governing body of the Economic Division of the Glass Industry, presided over by Dr. A. Rueckl, well known Czech industrialist. Of the other four members of the body, two are members of central organizations and two union leaders.

In the Czechoslovakian Ceramic Society, a Glass Division was organized under the chairmanship of Mr. Hrnicko; Dr. Ctyroky is the secretary of the Division. Publications will not appear in the Bulletin of the Czechoslovakian Ceramic Society, but in the "Sklarske Rozhledy", which will be not only the official publication of the Institute, but also of the Glass Division.

STAFF CHANGES AT NORTH AMERICAN REFRACTORIES

The appointment of Earl C. Petrie as Assistant Director of Research was announced recently by the North American Refractories Company. Mr. Petrie joined the organization's research department in 1940. He was graduated in Ceramic Engineering from Ohio State University in 1929. Prior to joining North American Refractories, Mr. Petrie was on the staff of the Refractories Fellowship of the Mellon Institute.

The company has also announced the retirement of Charles F. Sweney as Head of the Cleveland Engineering Department. He had held this position since 1929 when the company was formed. He was formerly associated with the Crescent Refractories Company.

Henry B. Knierim has been named to replace Mr. Sweney. He has been with the company since 1929 and had previously been employed by the American Steel and Wire Company.

GJ Research Digest

Practical Interpretations of Glass Technology

Comparison of Effect of TiO_2 and PbO on Light Absorption of Some Colored Glasses

It is a well known fact that colored ions assume different colors in various surroundings. Additions of PbO or TiO_2 cause colors of many ions to undergo major changes. For example, the blue color of copper shown in normal soda-lime-silicate glasses is changed to green when TiO_2 is added.

The influence of TiO_2 and PbO on glasses colored by the additions of Fe, Cu, U, Ce and Mu was studied by Colbert and the results of his study are reported in the February 1946 issue of the *Journal of the American Ceramic Society*. Two series of glasses were made by adding TiO_2 or PbO to a base glass of composition Na_2O, CaO, 5 SiO_2 (in weight percent this corresponds to 14.8 Na_2O, 13.4 CaO and 71.8 SiO_2). Additions were made on a Mol per cent basis. A third series of glasses was prepared in such a way that the composition of the glasses varied in five steps from a Na_2O, $4SiO_2$, glass to a PbO · SiO_2 glass. Spectrophotometric curves in the visible region were made for the three series of glasses.

The addition of TiO_2 or PbO to a soda-lime-silicate or a soda-silicate glass containing 1.0 per cent iron oxide causes the color to change from a light green to a dark brown. Approximately 50 mol per cent of PbO is required for this change while less than half this amount of TiO_2 is needed to produce the same color change. The green color of the iron-containing glasses is due to the simultaneous presence of ferrous and ferric ions. The brown color is produced by the ferric ion in four-fold coordination. In this position, the ferric ion assumes a role similar to that of Si^{4+}; it participates in the glass structure as a network former. Since the addition of either TiO_2 or PbO changes the green color to brown, it may be concluded that these oxides make it easier for the iron to assume network-forming positions.

Sodium silicate or soda-lime-silicate glasses containing 0.5 per cent copper oxide have a blue color. Additions of TiO_2 or PbO change this to green. In the higher coordination which corresponds to the network modifying position, the cupric ion has a blue color. The lower coordination of the cupric ion as a network former is characterized by a brown color. If cupric ions are present in both positions, a green color results. The change of the color on addition of TiO_2 or PbO indicates, therefore, an increase in the number of cupric ions in lower coordination.

The addition of 0.5 per cent sodium uranate ($Na_2U_2O_7$) to a soda-silicate or soda-lime-silicate glass produces a light yellow color and an intense green fluorescence which is due to the uranyl $(UO_2)^{2+}$ group. Additions of TiO_2 or of small amounts of PbO quench the fluorescence gradually and deepen the yellow. The deepening of the yellow and the disappearance of the fluorescence is indicative of a change from the cationic uranyl $(UO_2)^{2+}$ group to the anionic uranate $(UO_4) =$ group.

Two per cent cerium oxide added to a soda-silicate or soda-lime-silicate glass produces a blue fluorescence but no color. Additions of TiO_2 or PbO change the color to yellow and even small amounts quench the fluorescence completely.

To a soda-silicate or soda-lime-silicate glass was added 0.5 per cent of manganese in the form of pyrolusite and the glass was melted under reducing conditions. In manganese glasses, additions of TiO_2 and of PbO produce entirely different effects. A yellow color develops and deepens on successive additions of TiO_2. This yellow color is probably due to the four coordinated manganous ions in a network-forming position. Additions of PbO up to 20 mol per cent have no effect on the color. Further additions favor the oxidation of the manganous ions to manganic ions and produce a purple color.

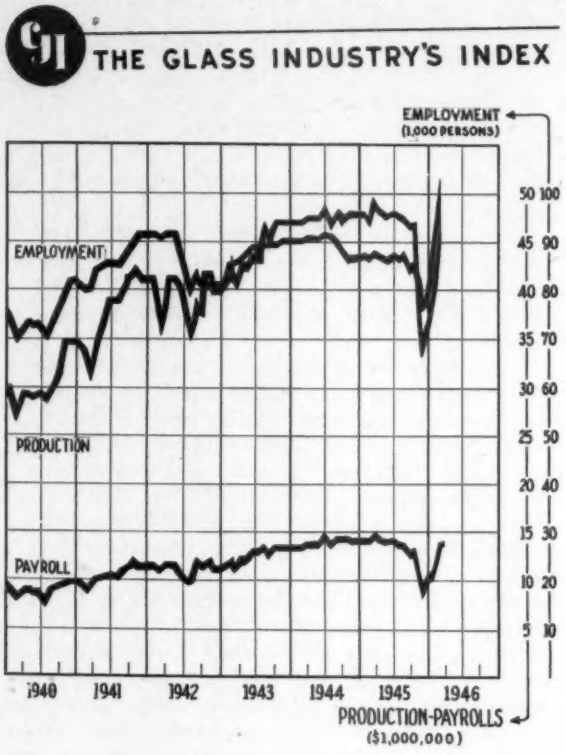
While studies such as these have for their primary purpose the investigation of glass structure, a secondary practical purpose is served inasmuch as the results obtained give the practical glass man clues on how to make variations of his ordinary glass colors and also why changing the base glass will often cause changes in the color desired.

Serviceability of Optical Glass

Several modifications of a powder - hygroscopicity method have been tried as a rapid means of determining the serviceability of optical glasses; that is, their ability to maintain a clear polished surface under normal conditions of service. The method has been applied by Donald Hubbard of the National Bureau of Standards, to a wide variety of glasses and, as reported in the *Journal of Research* for April (RP 1706), it shows that the typical optical glasses in common use are much less hygroscopic than the average commercial sheet and container glasses. In fact, many of the optical glasses even compare favorably with the better chemical laboratory wares such as Pyrex, Tamworth and Kimble N-51-a. This grouping of glasses of such dissimilar chemical durabilities serves well to emphasize that the capacity of a glass to maintain a clear surface upon exposure to the atmosphere, and its chemical durability as conveniently determined, are two inherently different properties. A comparison of the hydroscopicity values of the Corning 015 electrode glass with those of the optical and chemical ware glasses, the electrode capacity of which is very poor, suggests strongly that the pH response of a glass is primarily a function of its hygroscopicity.

• A dividend of 25 cents per share was voted at a meeting of the Board of Directors of the Hartford-Empire Company on April 26, 1946. The dividend is payable May 2 to stockholders on record as of April 26.

CURRENT STATISTICAL POSITION OF GLASS



Activity in the glass industry during March 1946 was indicated by the Production Index to be $49,500,000, which is about 4 per cent over the February figure of $47,600,000. Production during March 1945 was $49,000,000, which is only slightly lower than for March this year. Production thus far in 1946 is estimated at $136,000,000. During the same period in 1945, output was estimated at $143,000,000.

Employment and payrolls: During the month of March 1946, the total number of persons employed in the glass industry was 102,000 persons. This is a little over the 99,700 persons employed during February. Employment during March 1945 was reported to be 88,300.

Payrolls for March 1946 were estimated at $13,500,000, indicating an approximate 4 per cent increase over the $13,000,000 paid in February. March 1945 payrolls were $15,000,000. During the first quarter of 1946, glass manufacturers have paid approximately $37,100,500 in salaries.

Glass container production for the month of April 1946, based on figures released by the Bureau of Census, was 9,529,645 gross. This figure represents an approximate 3 per cent drop from the figure reported for March. March production was 9,872,373 gross. April 1946, however, is about 11 per cent above the April 1945 figure of 8,524,432 gross. Total production for the first four months of 1946 is 38,233,137 gross as compared with 32,862,951 gross produced during the corresponding months in 1945.

Shipments also dropped for the month of April. April shipments were 9,660,542 gross as compared with 9,839,971 gross shipped during March. Shipments during April 1945 were 8,975,871 gross—approximately 7 per cent below April this year. Total shipments so far in 1946 are 38,299,673 gross. Shipments during the same period in 1945 were 34,126,173 gross.

Inventories at the end of April 1946 were 4,167,899 gross in comparison with 4,287,338 gross at the end of March. Stocks on hand at the end of April 1945 were 4,412,568 gross.

It should be noted that two manufacturers were unable to report their figures in time for inclusion in the above compilation. Based on past records, these figures were

(*Continued on page* 304)

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in gross)

		Production April 1946	*Stocks April* 1946
Foods; Medicinal & Health Supplies; Chemcals, Household, Industrials; Toiletries & Cosmetics	Narrow Neck	3,158,991	1,786,821
	Wide Mouth ..	3,382,614	1,054,561
Dairy Products		331,935	149,610
Home Canning		207,888	412,995
Beverages, Returnable		564,699	357,861
Beverages, Non-returnable			
Beer, Returnable		581,697	127,955
Beer, Non-returnable		60,267	20,144
Liquors		847,146	195,277
Wines		302,803	46,382
Packers' Tumblers		91,605	16,293
Total		9,529,645	4,167,899

GLASS CONTAINER SHIPMENTS

(All figures in gross)

Narrow Neck Containers	*April* 1946
Foods	773,427
Medicinal & Health Supplies	1,170,476
Chemical, Household, Industrials	604,616
Beverages, Returnable	566,480
Beverages, Non-returnable	
Beer, Returnable	483,244
Beer, Non-returnable	62,832
Liquors	845,276
Wines	313,245
Toiletries & Cosmetics	535,853
Sub-Total (Narrow)	5,355,449
Wide Mouth Containers	
Foods	2,820,745
Dairy Products	346,515
Home Canning	237,834
Medicinal & Health Supplies	303,584
Chemical, Household, Industrials	111,906
Toiletries & Cosmetics	133,258
Packers' Tumblers	96,888
Sub-Total (Wide)	4,050,730
Total Domestic	9,406,179
Export Shipments	254,363
Total Shipments	9,660,542

DR. MAJOR E. HOLMES, DEAN OF N. Y. STATE COLLEGE OF CERAMICS, DIES

Dr. Major E. Holmes, Dean of the New York State College of Ceramics since 1932, died on May 2, 1946.

After receiving an A.B. from Indiana University, an M.S. and Ph.D. from Cornell, Dr. Holmes served successively as development engineer for The National Carbon Company, General Manager of The National Lime Association, development engineer for The Dolomite Corporation and as Head of the Department of Ceramic Engineering of The Missouri School of Mines.

Dr. Holmes' administration at The New York State College of Ceramics was marked by rapid growth of the college, the addition of two new departments of instruction and of the Department of Research. Further plans for the expansion and improvement of the College were just approaching maturity when Dean Holmes' career was cut short.

ALLEGHENY VALLEY GLASS COMPANY PURCHASES HEINZ PLANT AT SHARPSBURG

The Allegheny Valley Glass Company, a recently formed Pittsburgh organization, has purchased the glass container plant of the H. J. Heinz Company at Sharpsburg, Pa. It is the intention of the newly formed company to retain the present management and personnel, and to continue operation of the two tanks and the Owens glass forming machines at the plant.

The Allegheny Valley Glass Company has entered into an arrangement with the Brockway Glass Company, Inc., whereby Brockway will purchase the output of the Sharpsburg plant and render certain technical services.

John H. Bechtel has been elected president of the new firm and will combine these duties with those of general manager in the future. Mr. Bechtel was formerly general superintendent of the plant when it was owned by the H. J. Heinz Company.

AWARDS OFFFERED PROCESSING MACHINERY MANUFACTURERS

Opportunity for those engaged in the design, manufacture or construction of any type of processing or plastics machinery or parts is offered by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, in the announcement of their new $200,000 "Design-for-Progress" Award Program.

"Processing or Plastics Machinery" is admitted as one division of the "Industry Machinery" classification and includes any machinery used in glassmaking, pottery and various products. Processing machinery maintenance workers may also enter the competition under the program's "maintenance" classification.

Four awards, totalling $1600, established for this division of the "Industry Machinery" classifications are $700, $500, $250 and $150. Papers in this "Processing or Plastics Machinery" division are also eligible for the "Industry Machinery" classificational awards of $2500, $1500, $1000 and $800.

Three winners of divisional and classificational awards will also be possible recipients of the main program awards of $10,000, $7500 and $5000, respectively. The principal program award, which may be won by a paper in the "Industry Machinery" classification, is $13,200.

SYLVANIA ELECTRIC ELECTS PRESIDENT AND BOARD CHAIRMAN

The Board of Directors of Sylvania Electric Products, Inc., has announced the election of Don G. Mitchell as President of the company, and Walter E. Poor as Chairman of the Board of Directors.

Mr. Mitchell, formerly executive vice president, becomes, at the age of 41, one of the country's youngest presidents of a major corporation. He joined the company in 1942 after having been affiliated in sales capacities with McGraw-Hill Publishing Company, American Can Company, Marshall Field and Company and the Pepsi-Cola Company. He attended the University of Cincinnati and the University of Florida.

Mr. Poor, who has been President of Sylvania Electric since 1943, has been associated with the company since 1911. He is a brother of Frank A. Poor, founder of the company. A graduate of M.I.T. in Electrical Engineering in 1908, Mr. Poor serves on the Board of Governors of the National Electrical Manufacturers Association.

UNIVERSITY OF CALIFORNIA TO ERECT HUGE TELESCOPE

From the $30,000,000 appropriated for the University of California by Governor Earl Warren of California, $1,200,000 has been set aside for the building of a 120-inch telescope near the Lick Observatory atop Mount Hamilton, near San Jose in northern California.

The 18,000 pound lens will be 10 feet in diameter and 18 inches thick. Corning Glass Works has been awarded the contract. They were also contracted for the 200-inch reflecting type telescope built in 1934 at Mt. Palomar near San Diego.

Upon completion of the new telescope, California will have the distinction of having the world's two largest telescopes. Its two nearest rivals will be the 96-inch telescope for the University of Michigan's new observatory and the 82-inch telescope on Mount Locke, near Fort Davis, Texas. It is expected that the new telescope will be completed within two years.

PITTSBURGH CORNING EXPANSION PLAN

The Pittsburgh Corning Corporation recently announced plans to build two plants at Sedalia, Missouri, for the production of glass block and Foamglas. According to the announcement, the estimated cost of the expansion program is $2,000,000.

On the 40 acre plant site, a building will be constructed for the production of glass block, and facilities for Foamglas manufacture will be added as soon as building materials and equipment are available. When both plants get into full production, approximately 600 persons will be employed. Preliminary survey work is now underway by the building contractor, H. K. Ferguson Company of Cleveland, Ohio.

The Sedalia plant production will be routed to southwestern, midwestern and southern states.

• Pennsylvania Salt Manufacturing Company has announced the appointment of Dr. John F. Gall as Assistant Research Supervisor to assist in the coordination of the experimental activities of the Research Division of Pennsalt's Research and Development Department.

AMERICAN CHAPTER OF CHINESE CERAMIC SOCIETY FORMED

Editor,

THE GLASS INDUSTRY

China is one of the countries where fine articles of ceramics were produced long before the present industrial age. Realizing the importance of modernizing the ceramic industries in China, the Chinese Ceramic Society was founded some years ago.

During the war years, starting from 1937, the Chinese ceramic industries suffered severely. Under the extremely difficult conditions which then existed, the manufacturers in China were still able to turn out various ceramic products. Since the end of the war, the Chinese Government has made plans for the industrialization of China and has sent hundreds of students and engineers to this country for training. Among them, there are about twenty engaged in the various fields of ceramics.

During the recent meeting of the 48th Annual Convention of the American Ceramic Society at Buffalo, a number of these Chinese ceramists organized the American Chapter of the Chinese Ceramic Society. This branch will devote itself to the development of the Chinese Ceramic Industry by introducing American art, technique and scientific methods into China. The officers elected are: President, Kuan-Han Sun, recently elected Fellow of the American Ceramic Society; Secretary, Chen-Chung Tan, a specialist on refractories; and Treasurer, Gordon P. K. Chu, an expert on glass technology.

The American branch in New York City (Official address: care of G. P. K. Chu, Room 515, 111 Broadway) welcomes American ceramists who are interested in the Chinese activities to join as members. This branch is also collecting used ceramic books and old issues of journals and magazines for the war torn areas in China, and would appreciate the donations of these publications from American ceramists. The books and journals may be sent to the Chinese Ceramic Society, c/o Science and Technology Library, University of Pittsburgh, Pittsburgh, Pa.

Kuan-Han Sun

RECENT REPORTS RELEASED BY OFFICE OF PUBLICATION BOARD

Some German methods for growing quartz crystals which appear to have advantages over American methods and which should be tested in the United States are described in a recently issued report by the Office of the Publications Board. The report (PB-6498, 7 pages) was made by G. E. Guellich, John White and C. B. Sawyer, investigator for the Joint Intelligence Objectives Agency, and is a brief general discussion of German quartz growing methods. It is based primarily on interviews with German researchers.

A second report issued deals with precision metallization of glass and how it can be applied to production of precision resistors for pulse circuits and many other purposes. This research was conducted during the war at the Polytechnic Institute of Brooklyn under contract with the Office of Scientific Research and Development. To produce resistors of metallized glass, a metallic film is either baked onto the glass or evaporated onto the glass in a high vacuum. Temperature coefficients and power capacity of the baked-on and evaporated films are discussed in this report (PB-5186, 12 pages).

Dielectric constant and loss measurements for glasses, ceramics, waxes and many other materials over a high frequency range are now available to industry in reference table form in three reports recently released. The tables were compiled by researchers at the Massachusetts Institute of Technology under contract with the Office of Scientific Research and Development to facilitate application of dielectrics to the war effort.

Tables of measurements of dielectric constant and loss over a wide frequency range are contained in Report PB-4658, 205 pages. Information on composition, availability and recommended applications is included. Report PB-4660, 97 pages, includes data on the properties, uses and peculiarities of titanate ceramics.

Any of these reports may be obtained by writing to the Office of the Publication Board, Department of Commerce, Washington 25, D.C. Photostats are $1.00 and microfilm, 50 cents. Order should be accompanied by check or money order payable to the Treasurer of the United States.

GEORGE H. DAHLIN OF DIAMOND ALKALI DIES

George H. Dahlin, associated with the Diamond Alkali Company for 29 years, died suddenly from a heart attack on May 10. He was 57 years old.

Mr. Dahlin joined the Diamond Alkali Company in 1917 in the capacity of chief clerk in the sales department. In 1929 he became a salesman working out of the Pittsburgh office. He became manager of glass industry sales last year.

Mr. Dahlin, a native of Pittsburgh, attended Iron City Business College and the University of Pittsburgh.

He is survived by his widow, Mrs. Elizabeth Scott Dahlin; a son, Hilmer A. Dahlin of Albion, Pa., and two brothers, Leonard E. of Pittsburgh and Horace O. Dahlin of Harrisburg, Pa.

HOUGHTON HEADS NATIONAL BOY SCOUTS

Amory Houghton, Chairman of the Board of Corning Glass Works, was recently elected President of the National Council of the Boy Scouts of America. Mr. Houghton has been a leader in Boy Scout activities since 1923.

Chairman of scouting in New York and New Jersey from 1933 to 1936, Mr. Houghton became Vice President of the national council three years ago. He has been on the national executive board since 1935.

DR. LEIGH FOWLER NAMED PATENT DEPARTMENT MANAGER

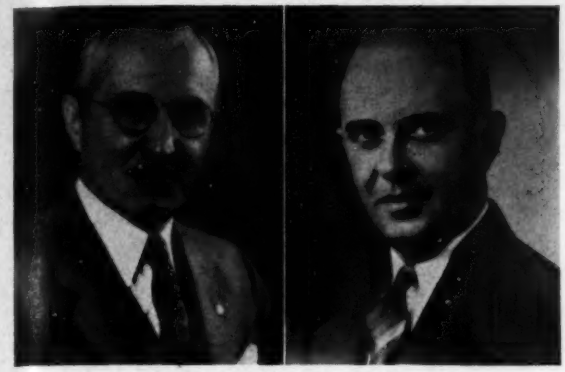
Corning Glass Works has announced the appointment of Dr. D. Leigh Fowler as Manager of the Patent Department. Dr. Fowler has been a member of this department for several years and was made assistant manager in 1944.

In 1931, Dr. Fowler received his degree of Bachelor of Arts at Brown University and his Doctor of Philosophy degree four years later. At Detroit College of Law, he won the degree of Bachelor of Laws.

Previous to joining Corning Glass Works, Dr. Fowler had been associated with Nash-Kelvinator Corporation.

CLEVELAND CRANE ELECTS OFFICERS

The election of Herbert T. Florence as President and General Manager has been announced by Cleveland Crane &



A. C. GARNETT H. T. FLORENCE

Engineering Company. Mr. Florence was General Manager of the company since 1938 and Vice President since 1941.

At the same time, the company announced the election of A. C. Garnett as Vice President and Treasurer. Mr. Garnett was formerly Secretary and Treasurer.

Also named were W. G. Wehr as Secretary and W. D. Vanderbilt as Assistant Secretary.

BOOK REVIEW

Luminous Tube Lighting
By A. H. Miller

Designed to explain the underlying principles of the luminous tube, summarize the materials and equipment involved and describe each of the discharge tube light sources, "Luminous Tube Lighting" is an aid to electrical engineers, contractors and students in acquiring up-to-date knowledge of all available types of electric lamps other than metallic filament or gas-filled bulbs.

When discharge tube practice became an integral part of the electrical industry and shortly after the advent of the fluorescent tube, war broke out. This book has been planned to enable electric engineers and contractors to pick up the threads. The book gives considerable attention to the low-pressure tube which will probably play a large part in the decorative lighting of the future.

The introduction covers the discovery of rare gases, cause of illumination, luminous tube light sources, etc., and is followed by a chapter on theoretical considerations. The third chapter deals with materials, and various types of glasses are discussed. Discussion of manufacturing equipment, low-pressure tubes, higher pressure tubes and the new fluorescent lamp follows. A chapter is then devoted to data and tests, after which neon signs are covered, and the last chapter is one headed "Miscellaneous," and deals with high intensity tubes, ripple tubes, aerial beacons, the neon fuse, etc.

REPORT ON METALLIZED GLASS ATTENUATOR ELEMENTS

According to a report released by the Office of the Publication Board, Department of Commerce, metallized glass attenuator elements, developed by American researchers, have made it possible to measure radio microwaves having frequencies in excess of 100 megacycles. In their work, the researchers borrowed from the ancient art of painting and firing china, as well as from modern techniques. The research was carried on by the Graduate Electrical Engineering Department of the Polytechnic Institute of Brooklyn, under contract with the National Defense Research Committee.

Beginning with the burning-on of noble metals, the scientists obtained thin deposits of various metallic substances on glass by chemical deposition by the cathode sputtering method and by evaporation of a metal in a vacuum. The evaporation method has come into general use for mass production of flat plates because it permits the film to be deposited easily and allows the resistance of the film to be controlled by regulation of the evaporation temperature of the filament. With this method, deposition can be stopped exactly when the desired value of resistance is obtained.

The finished coatings, averaging one-millionth of an inch in thickness, were protected by an additional coat of magnesium fluoride about ten-millionths (or more) of an inch thick.

PILKINGTON APPOINTS SALES MANAGER

Donald H. Jupp has been appointed Sales Manager of Pilkington Glass Limited, Toronto, Canada, one of the Canadian subsidiaries of Pilkington Brothers, Ltd., St. Helens, England.

Mr. Jupp, who joined the company in 1933, recently returned from five and a half years overseas with the Canadian Army as an administration staff officer. He was awarded the Order of the British Empire and retired with the rank of Lieutenant-Colonel.

FRENCH GLASS INSTITUTE PUBLISHES BULLETIN

The French Glass Institute, the foundation of which has been announced recently by THE GLASS INDUSTRY, has started the publication of a bulletin the first of which appeared on March 1, 1946.

The bulletin is edited by the well-known director of the Institute, M. Bernard Long. The Bulletin de I' Instut Du Verre proposes to "publish as frequently as possible original articles from foreign countries which have surpassed France in the organization, scientific or technological, of progress in the field of glass". By comprehensive documentation, the Bulletin will endeavor to bridge the admitted gulf between French and Anglo-Saxon literature.

The first issue, introduced by Dr. W. E. S. Turner, contains two original papers. Mrs. A. Winter extensively describes the physical foundations of glass annealing by the concept presented briefly at the last two meetings of the American Ceramic Society. Mr. M. Descarsin, of Thomson Houston and Compagnie des Lampes, has written an important paper on dielectric heating in the glass industry. This is the first paper on the subject about which so much has been heard in France during the last years. A digest of this paper appeared in the April issue of THE GLASS INDUSTRY.

The abstract section of the Bulletin starts out covering recent American work in a much more extensive manner than is currently used in abstract journals.

Attention . . .

Glass Tank Operators

For Maximum Life SPECIFY

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CURRENT STATISTICAL POSITION OF GLASS . . .

(*Continued from page* 300)

estimated and industry totals adjusted accordingly.

Plate glass production for the month of April 1946, according to the Hughes Statistical Bureau, was 18,514,580 sq. ft. which indicates a slight decrease from the 19,292,306 sq. ft. produced during March. April 1945 production was 8,488,938 sq. ft. which is considerably below that figure reported for April this year. Total plate glass production for the first four months of 1946 is 56,011,614 sq. ft. as compared with 33,763,118 sq. ft. produced during the same period in 1945.

Automatic tumbler production for the month of April 1946 totalled 6,935,081 dozens which is an approximate 10 per cent decrease from the 7,769,565 dozens produced during the month of March. April 1945 production of 5,158,868 dozens was about 34 per cent below production for the corresponding month this year. Shipments during April 1946 were 7,415,951 dozens. This figure represents a drop of about 3 per cent from March shipments which were 7,671,675 dozens. April 1945 shipments were 5,570,149 dozens, or about 33 per cent under April this year. Stocks on hand at the end of April 1946 were 4,410,267 dozens, as compared with 5,006,745 dozens at the end of March and 4,352,728 dozens at the end of April 1945.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware for the month of April 1946 dropped slightly more than 1 per cent to 4,100,213 dozens. Sales for March were 4,153,380. April 1945 sales were 3,130,105 dozens which is about 31 per cent below April this year. Total sales during the 12-month period ending April 1946 were 40,285,642 dozens.

REPORT ON GERMAN FIBROUS GLASS

Six basic methods were used by the Germans to produce fibrous glass, according to a report on the German fibrous glass textile industry released by the Office of the Publication Board, Department of Commerce. The report was made by technical investigators for the Joint Intelligence Objectives Agency.

Of the six methods, all but the "Schueller process" are well known in the United States. In the Schueller process, glass filaments about 10 microns in diameter are drawn from molten glass rods and accumulated in continuous lengths on a drum rotating at 800 revolutions per minute. Melting is effected by two sets of electric heating coils.

Each heating coil is enclosed on three sides. The glass rods (80 to 100 per machine) are supported vertically between rubber rollers and driven slowly downward. The lower ends of the rods are consumed as they pass between the heating units at a temperature of 1200 degrees Centigrade.

According to the report, production of fibrous glass textiles was stepped up by the Germans during the war to provide a relatively cheap substitute for asbestos and a high-price electrical insulating material. In general, the investigators discovered no novel developments.

CORHART SUGGESTS "A COMMON DENOMINATOR"

WHAT productivity should one expect from a given glass furnace?

If Tank "A" produces 45,000 tons of glass during one campaign and Tank "B" produces 84,800 tons, is Tank "B"'s performance the better?

Or if Tank "A" has a run of 500 operating days and Tank "B" a run of 600 days, which is the better performance?

Obviously other factors are involved, including the size and design of the furnace and the nature of the glass and product.

To compare one glass furnace with another of similar design and operation, a "common denominator" of tank production is obviously needed. It is apparent that *total tons produced* and *total days operated* are in themselves inadequate when comparing furnaces of different sizes.

AS a "common denominator" to reduce the operating factors to a comparative basis, we have, for some years past, been using the expression:

TONS, PER SQ. FT. OF MELTING AREA, PER LIFE

TONS = Total weight glass pulled, i.e., shear cuts
SQ. FT. MELTING AREA = Total area of melting end, not including the doghouse
LIFE = Period of one campaign

The use of this "Common Denominator" can be illustrated by the following four hypothetical examples: —

	Tank No. 1	Tank No. 2	Tank No. 3	Tank No. 4
Tank Melting Area (Sq. Ft.)	450	354	532	702
Total Tons Produced	49,150	43,112	59,158	69,390
Total Operating Days	655	658	633	653
Sq. Ft. per Ton per Operating Day	6.0	5.4	5.7	6.1
Tons, per Sq. Ft., per Life	109.2	121.7	111.2	98.8

Here are the performances of four tanks of various sizes, operating for different periods under different loads. Yet their performances are placed on a comparable basis by the use of the "Common Denominator" of TONS, PER SQ. FT. of MELTING AREA, PER LIFE.

By using the above "common denominator," we believe that glass factory operators will find the analysis of their own furnace performances interesting and profitable.

Corhart Refractories Company, *Incorporated,* Sixteenth and Lee Streets, Louisville 10, Kentucky.

QUALITY ECONOMY ENDURANCE

CORHART ELECTROCAST REFRACTORIES

ELECTRICAL ANALOGY METHODS . . .

(*Continued from page* 290)

show the diagrams of simple cases. Much more complicated conditions can also be imitated. In the case of two or three dimensional heat flow, a network is arranged with resistors being connected according to the main directions of flow of heat. At the intersection of each pair of resistors, a capacitor is applied representing the heat capacity of the section.

In cases where heat and mass transfer are combined in a definite manner (flow of material in a continuous furnace, flow of air or gas in a regenerator), preloaded capacitors are being used. Arrangements with two or more different fixed or variable potentials (temperatures at different parts held at constant temperature or subject to a definite time temperature curve) have been designed. Thus, based on the fundamental analogy a great number of various cases can be investigated.

An additional advantage of the method is that the time necessary for a heat process can be represented in the electrical analogy by a process taking longer, equal or shorter time. For example, a 24-hr. heat flow in a wall can be investigated in an electric experiment of 10 or 15 min. duration. The cooling of a weld, taking place in a few seconds, can be represented by an electric experiment lasting 5 to 10 minutes.

The application of the method thus outlined is facilitated by a machine erected in the Mechanical Engineering Department at Columbia University. A large number of resistors and condensors are so arranged as to allow ready connection in any desired circuit. Provision is made to change resistance and capacitance during the experiment, representing a change of thermal conductivity and capacitance with temperature.

Recording instruments allow the automatic recording of 4 voltages (corresponding temperatures). A milliampere-minute meter yields the total stored heat units (Btu), while milliamp meters can be applied at various points to determine the heat flow (Btu/hr).

The number of problems which can be solved on the machine is practically infinite. For example, in the glass and ceramic field, problems such as the following may be solved: Too rapid drying rates (of intricate shapes and large pieces), and too high a rate of firing, are probably among the outstanding reasons for difficulties in the manufacture of refractories. Among the transient heat flow problems in the manufacture of glass is the cooling of the glass in the mold, the annealing of glass (consisting of slow reheating and subsequent cooling); the curing of the pots in which the glass is melted is another example. In the case of regenerator, the cycle of existing regenerators, as well as new ones (thickness and material of checkers; width of flue) are mostly determined by empirical methods only. A systematic investigation may well result in increased furnace output and reduced fuel cost. The walls of intermittently operated furnaces call for special design. The heat loss is not proportional to the time of operation; correct design of a wall will not only result in better heat economy as a rule, but frequently also in more satisfactory duty because the furnace with such walls does not cool faster or slower than necessary for the charge.

Space does not permit listing all applications of the method. However, it should be noted that, in principle, any transient heat flow problem can be solved by this method. The practical solubility of any problem will depend largely on the geometry involved (necessitating a greater or smaller amount of equipment). Another limiting factor in the practicability of the method is to be seen in the boundary conditions. Rapidly changing or too complicated boundary conditions may call for electrical equipment not available at present.

INVENTIONS AND INVENTORS . . .

(*Continued from page* 296)

invention greatly reduces this difficulty by the use of a flux containing at least one fluoride of an alkali metal or alkaline earth metal examples of which are lithium, sodium, strontium, etc.

A proper glass composition is, of course, necessary and three examples of suitable glasses are given below:

Name of glass	SiO_2	Na_2O-K_2O	B_2O_3	PbO	Al_2O_3	Miscellaneous oxides
Corning thermometer glass 752	72	10	10	..	5	3
Corning "Nonex" 772..	73	4.5	16.5	6	..	..
Corning "Pyrex" 774...80.5		4.2	12.9	..	2.2	0.2

Sodium fluoride is recommended as a satisfactory and inexpensive flux. The metal may be dipped in a saturated solution or the flux may be applied in other obvious ways. A strong and leak-proof seal is thus provided.

British Patent No. 2,400,056 was assigned to the English firm of Chance Brothers & Company by the inventors, Wheat and Bullock. A periodic kiln is shown which provides a more uniform temperature for annealing optical glass than has previously been obtainable.

A vertical section of this kiln is shown in Fig. 4. A refractory chamber a is provided with a removable cover b having electrical heating elements c which are also provided in the sides and bottom of the chamber. Insulating material indicated at e and f surrounds the chamber being enclosed by casings d and g.

The glass h is annealed by circular trays i having a vertical central passage k and an outer annular passage m. A fan n is mounted in the center of the bottom of the chamber and driven through gearing s by a motor r. All the inner surfaces of the chamber and cover are curved to facilitate the flow of air. By a proper adjustment of the heat in the cover and on the sides and the flow of air up through the passage m and down through the central passage k, great uniformity in the temperature of the kiln is obtained.

SLICK GLASS COMPANY OPENS ARCADIA PLANT

The Slick Glass Company, Inc., is opening a plant in Arcadia, Indiana. David J. Jones is plant superintendent.

Two machines for the manufacture of pressed and blown glassware are on hand and two more have been ordered. Sixty persons are now employed and this number will be doubled when the new machines arrive. A similar plant is operated at Gas City, Indiana, and in the East.

From the Lowest to the Highest Point

Panamint Mountains to the West, the Armagosa Range to the East, the Last Chance Range to the North, with Owlhead and Avawatz Mountains in the South, hemming in Death Valley in a natural fortress. A few passes or gaps, permit entry at lower levels along the 150 miles of Death Valley. It is 20 miles wide and narrowing to about 6 miles.

Death Valley is situated in southeastern California, in Inyo County, adjoining the Nevada line. The center of the valley is approximately 300 miles east of Los Angeles and about 135 miles west of Las Vegas, Nevada. The valley is barren with sand and dried salt marsh, except in spots, particularly at Bad Water, an area where the moisture finds the lowest level to collect into a small lake. The water is rank with salt and mineral deposits, although a type of small minnow-like fish abounds.

A sign at Bad Water marks the lowest point in the western hemisphere, 279.6 feet below sea level. On a clear day, one can see a distance of 80 miles, the top of Mount Whitney, 14,501 feet above sea level and the highest point in the United States . . . from one extreme to another.

FLUXING ACTION – The speed with which the constituents contained in a glass batch can be melted into a homogeneous mass and brought to a satisfactory working state determines the output of a tank. B_2O_3 is one oxide which through its fluxing action, increases the rate of melting.

Another good reason why Borax should be used as an essential ingredient in the batch formula.

Our representatives are prepared to discuss the special advantages of B_2O_3 in glass.

PACIFIC COAST BORAX COMPANY

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PITTSBURGH PLATE DEVELOPS WINDOW INSULATING UNIT

Pittsburgh Plate Glass Company has recently announced the development of a new type, double-glazed window insulating unit for industrial, home, business, commercial and special use. The unit will be known as Twindow.

Twindows are integral insulating units of two or more plates of glass enclosing a quarter-inch or half-inch hermetically sealed air space. One of the revolutionary features of Twindow is use of hollow aluminum tubing to separate and hold the glass plates in position.

The entire unit is framed with a light-gauge stainless steel channel (.015 to .020) with the channel legs extending three-eighths of an inch inward on the surface of the glass from the base around its periphery to give maximum protection during installation and use.

Clear polished plate glass is used in construction of the standard Twindow unit. In addition, however, the units can be fabricated with special glasses to meet practically all needs. For example, special units can be made of Solex heat-absorbing glass and plate glass. These units would be particularly adaptable for use in airport towers, large offices, or other locations where the direct rays of the sun pose a problem. The use of water white plate glass, which permits true color definition with a maximum clarity of vision, makes a Twindow unit that is ideal for use in test chamber multiple glazing. These units successfully combine the clear vision and high insulating value needed in all types of test chambers operating at extremely low temperatures, high and low pressures, and other unusual conditions.

Specially developed production processes make it possible to provide the Twindow units in a wide range of sizes in any combination of straight edges. These units include the standard double-glazing as well as the special triple, quadruple, and multiple glazed panels. It is also possible to produce certain simple cylindrical bends within definite limitations.

Some of the initial uses of the double glazed principles were in production and operation of war materials and equipment. They were included in the glazing units designed for aerodynamic testing chambers such as wind tunnels. In the latter use, the Twindows were subject to extreme pressures, and performed most satisfactorily. Similar principles were also used in windshield construction of many of the aircraft flying at extremely high altitudes.

PITTSBURGH PLATE SAFETY DIRECTOR RETIRES

According to an announcement by Pittsburgh Plate Glass Company, Clarence E. Ralston has retired as Safety Director. Mr. Ralston has been associated with the company's safety department for more than 23 years and had previously held the position of Assistant Safety Engineer with the Jones & Laughlin Steel Company.

During both World Wars, Mr. Ralston was active in safety work with government agencies. After World War I, he was associated with the Equitable Life Insurance Company. He is a member of the Western Pennsylvania Safety Council, American Society of Safety Engineers, the National Safety Council, the Industrial Hygiene Foundation and the Pittsburgh Personnel Association.

Penn Salt's

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etches and polishes

HEISEY GLASSWARE

ANHYDROUS HF

was first produced commercially in our Easton, Penna., plant. It is used as an alkylation catalyst in the production of high octane gasoline. It is also used in the production of organic fluorine compounds, in the synthesis of other organic compounds, and for the preparation of high purity inorganic fluorine compounds. Shipped in cylinders and tank cars.

For the etching and polishing of fine glassware, Penn Salt's Hydrofluoric Acid is used more today than ever before. It is also valuable in cleaning steel, for the frosting of light bulbs, and for many other industrial purposes.

Hydrofluoric Acid strengths below 60%, and special grades of 60% are shipped in rubber drums. Strengths from 60% to 80% in steel drums.

For complete information, write to Pennsylvania Salt Manufacturing Company, Widener Building, Philadelphia, Pa.

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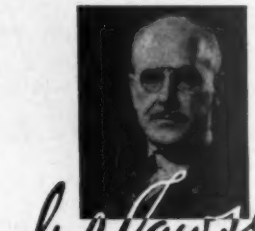
UNION COMMERCE BUILDING
CLEVELAND, OHIO

To our many friends of the glass industry, we are pleased to announce the merger of W. B. Lawson, Inc., and Ferro Drier & Chemical Co. under the new name—FERRO CHEMICAL CORPORATION. As in the past, we shall continue to furnish the same fine products and personalized service you have come to expect from the original organizations.



W. B. Lawson
PRESIDENT

Merchants, Manufacturers' Sales Agents, Industrial Chemicals and Nonferrous Metals, Warehouse stocks in New York, Cleveland, St. Louis and Detroit.

Distributors for American Potash & Chemical Corp. (Borax and Boric Acid); Darling & Co. (Oleic and Stearic Acids); Duquesne Smelting Corp. (Nonferrous Metals, Zinc Dust); Ferro Drier & Chemical Co. (Driers and Metallic Soaps); Lindsay Light & Chemical Co.; Merck & Co. (Laboratory Reagent Chemicals); Philadelphia Quartz Co. (Silicates); Stauffer Chemical Co. (Sulphur); Tennessee Corp.; Virginia-Carolina Chemical Co.; Wyandotte Chemicals Corp.; and others.

FLAT GLASS INDUSTRY FILES ANSWER . . .
(*Continued from page* 292)

organizations, warehouses, and who perform some processing functions. It was also cited that Pittsburgh Plate and Libbey-Owens-Ford in such a typical peacetime year as 1939 sold 70 per cent of the plate glass manufactured by them to the automobile industry largely in the form of safety plate glass.

In the window glass trade it is brought out that a prediscount list has existed to describe types, sizes, thicknesses and qualities of window glass—"a convenient mechanism for computing actual prices for these many thousands of variations in combinations of sizes, thicknesses and qualities of window glass through the medium of applying the discounts quoted by a manufacturer to such list or to particular brackets in the list." Each manufacturer independently quotes to the trade his own individual discounts, price changes are effected by changes in such discounts, and changes in discounts have been frequent, although no substantial changes in the prediscount list have been made since 1900 and long prior thereto, the defendant companies explain.

The government has charged the glass companies with seeking to keep out foreign competition, prevent export of glass, and divide world markets with foreign manufacturers, all of which charges are denied by the defendants.

Government allegations regarding control of safety glass manufacture are denied with the answer that patent transactions were for the purpose of quieting infringement actions and settling claims on certain processes of manufacture of safety glass.

The defendant companies declared that the government had not set forth correctly the terms of a licensing agreement between Pittsburgh Plate and Libbey-Owens-Ford made in 1932 the net result of which was "that they settled without litigation their respective claims for infringement." It was also said that all licenses made under the agreement were non-exclusive, each company has remained free to license others, and some licenses have been granted.

Coordinating the legal work for all defendants are Cahill, Gordon, Zachry & Reindel of New York.

Separate answers were filed by Fourco Glass Co., and Rolland Glass Co., both of Clarksburg, W. Va., and Eugene Rolland and W. M. B. Sine, through Welles, Kelsey, Fuller, Cobourn & Harrington, Toledo, and by Corning Glass Works, Corning, N. Y., and Amory Houghton, its chairman of the board, by Shearman & Sterling & Wright, New York.

The larger group of defendants filing an answer include Libbey-Owens-Ford Glass Co., represented by Marshall, Melhorn, Wall & Bloch, Toledo; Pittsburgh Plate Glass Co., represented by Leland Hazard, vice president and counsel, and Fraser, Shumaker, Kendrick & Winn, Toledo; American Window Glass Co., represented by Reed, Smith, Shaw & McClay, Pittsburgh; Blue Ridge Glass Corp., Franklin Glass Corp., and American Securit Co., represented by Fulton, Walter & Halley, New York; and National Glass Distributors' Association, represented by Yager, Bebout & Stecher, Toledo.

The court has called a pre-trial conference of all parties in the suit for June 17 in Toledo and has set the case for trial on October 7, 1946.

TECO The Bottle Stacker

ECONOMY OF OPERATION AND UPKEEP

This compact bottle stacker is installed outside of the lehr and is not subject to deterioration from heat. All parts are readily accessible for quick adjustment and economical maintenance.

An endless belt carries the bottles to the lehr. When a full row is assembled an air-operated ram arrests the bottle movement while a cam actuated pusher transfers the row of bottles to the lehr belt and returns to the idle position. The ram then withdraws, the bottles again move forward and the cycle is repeated.

The stacker is readily adjustable to handle bottles of various shapes and sizes up to two quart capacity. The speed is also variable to be synchronized with the speed of the lehr belt.

TECO Stackers are advanced units for use with TECO Lehrs and are equally well adapted for use with equipment of other makes. Let us explain its features in full.

TOLEDO ENGINEERING Company

GLASS MELTING and MANUFACTURING EQUIPMENT

EASTERN OFFICE 220 E. LEXINGTON ST. BALTIMORE MD. • • • 958 Wall St. TOLEDO. O.

RIGHT and LEFT HAND TECO STACKERS being installed on TECO LEHRS

GLASS DIVISION HOLDS ANNUAL MEETING . . .

(*Continued from page* 288)

pansion, high softening point, high chemical resistivity, etc., have been associated with a "strong glass structure" by some investigators. A comparison of the relative hardnesses of vitreous silica and soda-lime-silica glass affords a good illustration of the danger of explaining hardness wholly on the "strength" of the structure as exemplified by a low coefficient of thermal expansion. Although the indentation hardness of both are about the same, the coefficient of linear thermal expansion of the soda-lime glass is over 100 times that of vitreous silica.

The hardest glass was obtained by the substitution of beryllia for silica in the base glass. Knoop hardness numbers of 660 and 690 were obtained on glasses containing 6.8 and 6.9 per cent beryllia, respectively. Other oxides which yielded homogeneous glasses having Knoop hardness numbers of 600 or greater contained magnesia, ceria, thoria, nickel oxide or iron oxide. The Knoop hardness of glasses containing the various other materials in the specific amounts used did not differ in hardness to any appreciable extent (average approximately 550). The lowest Knoop hardness number, 380, was obtained with a soda-lead oxide-silica glass.

Constitution of Extra Dense Flint Glasses. *By K. Fajans and N. J. Kreidl.* (*K. Fajans*), *Department of Chemistry, University of Michigan, Ann Arbor, Mich., and Glass Science, Inc., State College, Pa.* (*N. J. Kreidl*), *Bausch & Lomb Optical Company, Rochester 2, N. Y.*

The deformation of ions plays an important role in the asymmetrical or random arrangements instrumental in glass formation. In the case of low silica glasses this factor is decisive since the continuity of Oxygen silicon oxygen linkages is no longer responsible for the random network. Silicon deforms oxygen very much, modifies like sodium or calcium very little. Aluminum and beryllium deform oxygen as much or more than the equivalent amount of silicon. The quantity of deformation was derived on the basis of the fundamental studies of Fajans from molecular refractions of a large series of silicates. Aluminum and beryllium thus become "intermediate glass oxides" and are capable of promoting glass formation although their pure oxides do not form glass. Large cations, like Ba++ are deformed by oxygen in turn, and the asymmetry is increased.

X-ray measurements indicate that in PbO the distance from Pb++ to one set of oxygen neighbors is smaller than that to another set. It is concluded that the divalent lead ion with its 18 electrons on the last completed shell and two more on the uncompleted shell is strongly deformed when combined with oxygen. When PbO is added to SiO_2 this deformation contributes to the asymmetry of the system and to the stability of extra dense flint glasses of low silica content.

Some Experiments on Crystal Growth and Solution in Glasses. *By Howard R. Swift, Libbey-Owens-Ford Glass Company, 1701 East Broadway, Toledo, Ohio.*

Two methods are described for measuring rates of crystal growth. The first is an adaptation of Dietzel's method wherein small fragments of glass are heated for varying lengths of time at different temperatures after which they are sectioned. The crystal lengths are measured microscopically.

The second method consists essentially of heating a very small fragment of glass in a platinum cup which has a small hole in the bottom. This arrangement permits direct observations of individual crystals which are grown or dissolved at controlled temperatures. Rates of crystal growth and solution can be measured readily at temperatures near the liquidus temperature of the glass being studied.

The length of a crystal growing in a series of glasses was found to be a linear function of time and the rate of solution was found to be continuous with the rate of growth curve through the liquidus temperature, solution being considered to be negative growth.

The importance of dust in promoting surface devitrification was shown by breaking samples in atmospheres with and without filtered air present with subsequent devitrification.

A possible method of studying the interdiffusion of similar glasses is presented with some results and further recommendations for the use of this method.

Ultraviolet Transmitting Glasses for Mercury Vapor Lamps. *By Martin E. Nordberg, Corning Glass Works, Corning, N. Y.*

The glass envelope of a bactericidal lamp should have a high transparency to the 2537A resonance mercury radiation and should not lose this transparency as a result of exposure to the ultraviolet radiation from the arc. Transmission at 1849A should in general be low to avoid ozone formation. Pyrex brand glass No. 9741, developed specially for this purpose, has the highest transmission at 2537A of any conventionally melted glass. Its transmission decreases on exposure to ultraviolet radiation, but remains about 50 per cent per millimeter at 2537A after prolonged exposure. So called ultraviolet window glasses have practically no transmission at this wave length. Vycor brand glass No. 791, made by a unique process, has an initial transmission of about 85 per cent for a thickness of one millimeter. Since there is an eight per cent reflection loss the maximum possible transmission is 92 per cent. After 230 hours exposure to the Hanovia Arc the transmission of a typical sample had fallen only 2.5 per cent of the initial value, as compared to 32.5 per cent for a sample of No. 9741 and one per cent for one of fused silica. In another experiment, test pieces of No. 791 glass were exposed directly to a low pressure mercury arc by placing them inside a lamp. No loss in glass transparency due to exposure to ultraviolet and a 12 per cent loss as the result of the darkened layer which forms on a glass surface, called "mercury blackening", were observed after a 2000 hour test. Finally, low pressure mercury vapor lamps both of the hot and cold cathode types were made with No. 791 glass envelopes. The decrease in 2537A outputs of these lamps and the relative outputs of the hot cathode lamps and similar commercial lamps with No. 9741 envelopes are given after lamp operation times up to nearly 6000 hours. The overall output in the first 5000 hours of operation of the hot cathode lamps with Vycor brand No. 791 glass envelopes is about twice as great as that of the No. 9741 glass lamps.

Vycor brand glass No. 7911 is well suited for sunlamps or other medium pressure mercury vapor arcs. It has a transmission above 85 per cent for all wave lengths over 3000A and does not deform or outgas at the relatively high temperature at which the arc tube operates.

Electrical resistance, power factor, and power loss data for glasses Nos. 791 and 7911 are given with comparison to fused silica. The electrical resistance, measured at 250° and 350°C., of No. 7911 glass is equal to and the power loss at 20°C. and one megacycle is slightly lower than the corresponding values for fused silica.

The Effect of Magnesia and Alumina on the Rate of Crystal Growth in Some Soda-Lime-Silica Glasses. *By Howard R. Swift, Libbey-Owens-Ford Glass Company, 1701 East Broadway, Toledo, Ohio.*

Measurements were made of the rates of cyrstal growth in a series of glasses with 74% SiO_2, 16% Na_2O, and 10% (CaO+MgO), the MgO replacing the CaO in 2% steps; and in a series of glasses with 17% Na_2O, 12% CaO, and 71% (SiO_2+Al_2O_3), the alumina replacing the silica in 2% steps up to 8% Al_2O_3. A study was also made of the rate of crystal solution in the series with variable alumina.

The substitution of magnesia for lime in the soda-lime-silica glass decreased the maximum rate of crystal growth for both the primary phase, cristobalite, and the secondary phase, devitrite, until the composition with the minimum liquidus was obtained. The maximum rates of growth of diopside and $Na_2O.2MgO.6SiO_2$ were increased with further substitutions of magnesia for lime.

(*Continued on page* 319)

NEW EQUIPMENT AND SUPPLIES

BLANCHARD VERTICAL SURFACE GRINDERS

With suitable variations, the method of mass production grinding of flat surfaces is now being applied to the grinding of glass, quartz, ceramic materials and sapphire. The machines used in the new application are Blanchard vertical surface grinders manufactured by the Blanchard Machine Company, 64 State Street, Cambridge, Mass.

Glass pieces are loaded into simple fixtures called "blocks" which have raised edges to confine the work within the outside diameter of the blocks. At

least the base of the block is made of cast iron or steel, i.e., materials capable of being magnetized. This feature permits the blocks to be held very securely on the rotary electromagnetic chuck of the grinder.

The work having been mounted on the chuck, the table is moved horizontally to bring its center under the face of the large cylindrical grinding wheel. The chuck rotates in a direction opposite to that of the wheelhead. The wheelhead is fed gradually downward until the desired size of work is reached. Material is removed from the work by a rapid succession of very shallow cuts over the entire face of the work. The limits of tolerance range from .0001" to merely obtaining a flat surface.

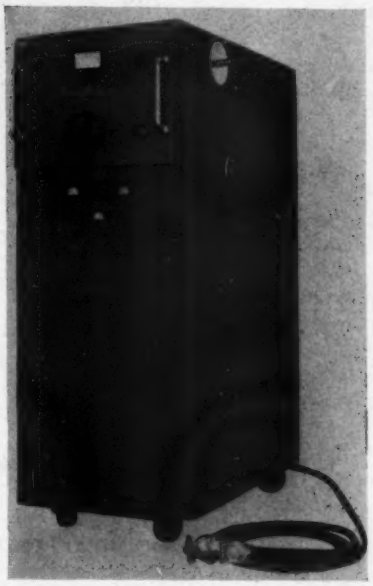
The same features which allow the Blanchard to grind off metal rapidly also suit its application to the rapid grinding of glass. A submerged centrifugal pump supplies a large amount of coolant to the inside of the grinding wheel and to an outside nozzle which is directed onto the work. This feature makes the grinding operation exceptionally cool—there is no appreciable temperature rise at any point in the material. The work and the grinding wheel revolve in opposite directions. Material removal is rapid, it being possible to remove as much as 5 cubic inches of glass per minute. The circular magnetic chuck eliminates clamping or other time-consuming methods of holding the fixtures containing work to be ground.

RAYTHERM DIELECTRIC HEATING UNIT

Industrial Electronics Division of Raytheon Manufacturing Co., Waltham, Mass., has introduced the Raytherm unit featuring dielectric heating that can greatly reduce production costs in almost every industry.

Because dielectric heat is generated within the product itself, the unit is a great time-saver. It eliminates the necessity of steam heated platens and has the ability to suspend heating operations immediately.

Raytheon's Model D5G, 5 KW general purpose Ratherm is 5′ 11⅝″ high, 2′ 4″ wide and 3′ 10⅞″ long. It is constructed of heavy-gaged sheet metal ribbed for strength on a welded, structural shape framework, and is complete in one cabinet. Maximum KVA demand from a 230 or 460 volt, 3 phase, 60



cycle line is 13.3. Each unit is complete with meters, cycle timer, interlocks, safety switch and all necessary control circuits for push-button operation.

ELECTRONIC POTENTIOMETER-PYROMETER DEVELOPED BY BAILEY

Bailey Meter Company, 1050 Ivanhoe Road, Cleveland 10, Ohio, announces its new Electronic Potentiometer-Pyrometer which has no continuously moving or vibrating parts in its measuring circuit. The new pyrometer records one or two temperatures on a 12″ diameter uniformly graduated chart and indicates on a 29″ bold scale which encircles the recording chart.

This indicating, recording and controlling instrument requires a 115 volt, 60 or 50 cycle, a-c power supply. It operates from a thermocouple or from any source of d-c potential which varies through at least 10 millivolts for full scale range. Conventional thermocouples are used for temperatures up to 3000°F. For temperatures above 3000°F. and for moving objects above 1500°F., radiation type thermocouples are used.

The d-c potential of the thermocouple or other primary element is balanced against a conventional potentiometer circuit employing the usual battery source of d-c voltage and a standard cell with manual standardization. Instead of a galvanometer or millivoltmeter, the Bailey Pyrotron Potentiometer circuit employs a d-c to a-c converter and an electronic detector to measure potentiometer unbalance.

CATALOGUES RECEIVED

The Dampney Company of America, Thurmalox Division, Doylestown, Pa., has issued a bulletin covering Thur-Ma-Lox, a coating which protects metal surfaces in power and process equipment against temperature damage from sub-zero to red-hot.

Thur-Ma-Lox coatings give effective and durable protection, providing a coating impervious to weather and industrial atmospheres up to the temperature limit of organic materials. The bulletin lists the story of these coatings, what they do, how they are applied and typical applications.

General Electric Company, Chemical Department, Pittsfield, Mass., has issued a 24-page booklet on G-E mycalex, a stone-like product composed of mica and a special glass.

The booklet describes in detail both the technical and manufacturing data compiled by General Electric in its 23 years mycalex production. It lists properties, available types, molded parts, fabricated parts, machine practice and how and where to order the material. Also included is a properties chart of six grades of mycalex of both the compression and injection molded types.

The design section of the booklet explains the size range, thicknesses, undercoats, taper, radii, holes and inserts that are practicable in molding mycalex parts.

United Electric Controls Company, 69 A Street, Boston 27, Mass., has issued a catalogue covering its electric temperature and pressure controls.

Illustrations and descriptive matter are presented for Types K, T, I, N, U & UL, Ne & NT and IE & IT thermostats. Applications, mounting procedure, tables and diagrams are given for these thermostats.

The catalogue also includes similar data on electric pressure switches—Types ACP3, ACP4, LR, L, EJR & EGL, P and R.

BAUSCH & LOMB OPTICAL PRODUCTION IN WARTIME . . .

(*Continued from page* 291)

be cracked by slight overheating. Later, the main burners are lighted and gas consumption increased at intervals to produce the proper time temperature cycle for preheating the clay pots.

When properly heated, the clay pot is transferred to a regenerative type, direct fire, down draft melting furnace with hearth dimensions of approximately 8 ft. wide and 8 ft. deep and heated to between 2400°F. and 2700°F. depending on the type of glass being produced.

There are three single pot furnaces primarily for optical glass melting and seven four-pot furnaces used for both optical and opthalmic glass. All furnaces are lined with silica brick, including the crown, and the side walls are backed up with good grade firebrick.

Air for combustion is induced upward through the checker work where it picks up heat from the hot bricks and its temperature is raised to approximately 1800°F. Gas, at approximately eight inches water column, is supplied through side port pipe burners and mixes with the upstream columns of preheated air. Here combustion starts and produces a soft, incandescent sheet of flame. This overhead blanket literally pours radiant heat down onto and around the pots of glass to produce the most effective method of heating and melting high quality optical glass in pots. While combustion of the gas and preheated air is taking place on one side of the furnace, the hot exhaust gases pass down the air passages on the opposite side of the furnace, thence through the regenerator chamber and are discharged finally into an outside chimney. During this phase of the cycle the checkerbrick in this regenerator chamber absorb waste heat from the exhaust gases. At the end of twenty minutes the cycle is changed by reversing the flue damper, gas valve and air intake. The air now passes up through the hot checkerbrick, the gas burns from the other side of the furnace and the cool checkerbrick chamber is reheated. These reversals serve to continuously provide preheated air and to even out temperature differentials across the furnace.

These furnaces are operated continuously, but the operating temperatures range from a maximum of 2700°F. to a minimum of 2200°F. every day. However, many years of experience and much careful thought and planning have developed a method of furnace rebuilding that has increased the operating life of a furnace from an average of 2 years to over 4 years. Whatever type or size of furnace is used, two factors are fundamental to the production of good glass—maintenance of a definite temperature over a long period of time and constancy of temperature distribution within the heating chamber so that the pot is uniformly heated.

The melting and refining operations are usually carried on at 2600°F. while during the slow cooling stages the temperature is lowered to 2200°F. The molten glass is mechanically stirred during the entire process by means of clay tubes attached to the ends of water-cooled pipes. These pipes are inserted through a front opening and are mounted outside the melting furnace on a special design machine. This provides slow turning of the machine end of the pipe in easily adjusted diameters of circles and this movement is, of course, reproduced at the stirring tube end of the pipe.

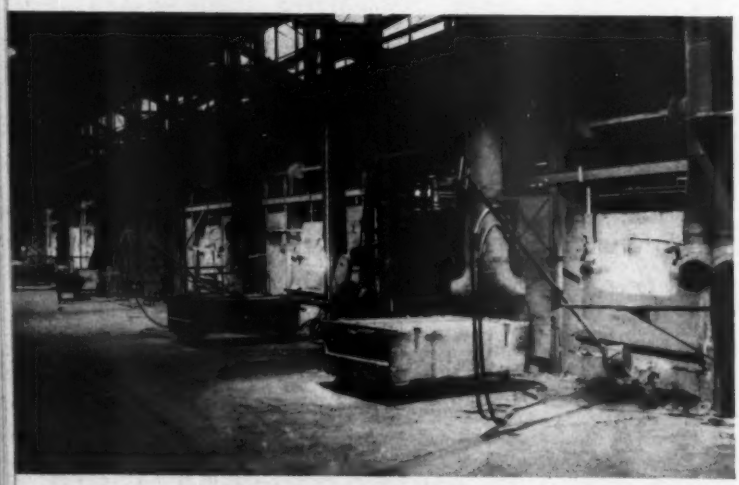
Carborundum cylinders with one closed end are mounted in the side walls of the furnace. One tube is placed in each cylinder, the end closed with a cast clay stopper, and furnace, cylinders and tubes all heated from cold to 1800°F. in nine hours. The manufactured gas burners are the same type of low pressure gas, atmospheric air mixers and burners as used on the pot arch furnaces. Since installation of this type of furnace the tubes have been more uniformly heated and free from any possible carbon deposit on the surface of the tube.

When the melt is judged to be finished, the furnace door is lifted, a portable mechanical fork picks up the finished pot of glass and transfers it to a cooling drum. The entire process of melting and stirring has consumed from 24 to 48 hours, depending on type of glass produced, and the final cooling in the insulated drum takes 5 to 6 days.

At this point as is the general practice, the pot is then split away from the glass and the glass broken into chunks, examined and sorted according to size. After the defective pieces have been discarded, the glass passes to the trimmers, pressers, molders, grinders and polishers. It is again inspected and then returned to the vaults for eventual requisition by the optical scientists. They prescribe the type and shape to fit the design of the many optical instruments used by the Armed Forces and from now on for a great many peacetime precision instruments.

Thirty-one years ago, when few Americans even thought of the possibility of a World War, the Bausch & Lomb Optical Company, through the courage of William Bausch, founded the first large scale optical glass plant in the United States. On its Ninetieth Anniversary, November 3, 1943, Bausch & Lomb celebrated the production of 3,000,000 pounds of optical glass from Pearl Harbor to that date. This was not a gross figure, but net poundage of glass inspected, approved and ready for processing. Since then, the glass plant has passed still other milestones—4,500,000 pounds of optical glass and 100,000,000 molded lens blanks.

From a fuel standpoint, the Bausch & Lomb glass plant uses manufactured gas exclusively and is the largest consumer of this type of fuel in the world, outside of steel manufacture. During the past three years, its annual consumption has averaged 821,000,000 cubic feet (4,408,770 therms).



Some of the glass melting furnaces.

N. Y. METROPOLITAN SECTION OF A.C.S. MEETS

The New York Metropolitan Section of the American Ceramic Society held its third and final meeting of its fiscal year on May 22 at the Building Trades Employers Association Building in New York City.

J. E. Hansen, newly elected President of the Society, presented a talk on Modern Developments in Enameling and showed a moving picture produced by the Ferro Enamel Corporation, entitled "Modern Enameling Practice". John D. Sullivan of Battelle Memorial Institute and Vice President of the Society also attended the meeting and spoke briefly on affairs of the parent body.

At the business session, by-laws of the Section were adopted and it was decided to hold the first annual meeting during May 1947. The reason for the selection of this date is to give incoming officers who are elected at the annual meeting the entire summer in which to prepare a program for the first meeting of the new fiscal year normally scheduled for October.

CORNING PURCHASES PARKERSBURG PROPERTY

Corning Glass Works and the War Assets Administration have reached an agreement, subject to certain remaining conditions, for the sale to Corning of land and buildings owned by the government at Parkersburg, West Virginia. The plant was built by Corning for the Defense Plant Corporation in 1942 and has been operated by Corning during the war years.

The acquisition of this plant, it is stated, will afford Corning an opportunity to install additional production facilities and to allow for expansion of manufacturing operations. Availability of qualified manpower and relatively low-cost fuel were the two deciding factors in the company's decision to buy the plant.

During the early war years, optical glassware for range finding instruments, fire control equipment, binoculars, telescopes and aerial photographic equipment were manufactured at the plant. Pending the purchase of the plant, production has been limited to finishing gauge glasses, colored optical filters and certain laboratory apparatus.

SOUTHERN ALKALI LEASES LOUISIANA PLANT

The leasing of a major portion of the government-owned plant at Lake Charles, Louisiana, was announced recently by the Southern Alkali Corporation. The Southern Alkali Corporation is jointly owned by the Pittsburgh Plate Glass Company and American Cyanamid Company.

The Lake Charles plant was built during the war for the Defense Plant Corporation and was designed for the production of magnesium metal. Southern Alkali Corporation will use it to produce caustic soda and liquid chlorine. An extensive remodeling program will begin immediately and a long term lease on the property will commence when the renovation is completed.

• The Film Division of Owens-Illinois Glass Company is remaking the film, "Blowpipes," a history of glassmaking which was originally produced in 1940. The film is being remade with the assistance of J. Arthur MacLean, Curator of the Toledo Museum of Art.

DU PONT TO DEVELOP COLOR CARD FOR GLASS AND CERAMICS

Howard Ketcham, color engineer and product design consultant, has been retained to develop a color card for the Electrochemicals Department of E. I. du Pont de Nemours & Company, according to a recent announcement.

Mr. Ketcham has been for many years director of the Duco Advisory Service for the company's Fabrics & Finishes Department, and a consultant for that department and Du Pont's Plastics Department since establishing his own service in 1935. He will make a nationwide survey of color requirements in the ceramics field to determine the range of colors in demand.

The proposed ceramics color card of the Du Pont Company is expected to standardize the use of colors in lines now lacking regularized color selection. The color card will govern colors made available by the company to glassware manufacturers.

SYLVANIA NAMES DIRECTOR OF SALES

Robert H. Bishop has been named Director of Sales for all division and subsidiaries of Sylvania Electric Products, Inc., according to a recent announcement.

Mr. Bishop, formerly general sales manager of lighting products, joined Sylvania Electric in 1936. In his new position, he will be responsible for the coordination of selling policy in all divisions of the company as well as its subsidiaries, Colonial Radio Corporation and Wabash Corporation.

In addition, Mr. Bishop will have direct line responsibility for the sales organization of the lamp, fixture, radio tube and electronics divisions.

CORNING RESEARCH CLUB ADMITTED TO SIGMA XI

Marking the fourth time that an industrial science group has been admitted to membership in the Society of the Sigma Xi, Corning Glass Works' Research Club was installed recently as a member club of the Society.

Dr. J. G. Baker of the Harvard Observatory delivered the charge to the new affiliates. Prof. Carleton C. Murdock, representing the executive committee of Sigma Xi, presented the charter of membership to Dr. Gail Smith, Research Club President. Prof. E. C. Pollard, Yale physicist, was the principal speaker of the evening. His subject was "The Elementary Particles of Nature."

• The Fourth National Chemical Exposition will run concurrently with the semi-annual meeting of the American Chemical Society to be held in Chicago September 9 to 13. It is announced that the show, again sponsored by the Chicago Section of the ACS, will be held at the Chicago Coliseum from September 10 to 14. A record attendance is expected.

PLASTIC BANDS AND SLABS . . .

(*Continued from page* 294)

per sq. mm., that is, within ± 8 per cent of the average.

Bands on the basis of gelatin and of vinylic resins have been prepared with different glass contents. Fig. 1 shows their ultimate tensile strength in kg. per sq. mm. as the function of the volume percentage of glass in the material. Circles mean glass-gelatin, and triangles glass-vinylic resin combinations. The figure contains also some data for the ultimate tensile strength of vinylic resin fibers, 11 μ (i.e. 11.10^{-4} cm.) and 2 μ (i.e. 2.10^{-4} cm.) thick; these data are found on the ordinate corresponding to the zero percentage of glass. On the ordinate corresponding to 100 per cent glass, strength values are indicated for glass filaments 20, 16, and 12.10^{-4} cm. thick.

Fig. 1 proves that the strength increases on the whole linearly with the glass content, but the validity of this rule is somewhat restricted by the wide spread of individual values. There is not much difference between the strength values of bands on gelatin and on vinylic basis. The increase of strength observed when the glass content rises is attributed not only to the greater area of glass supporting the load but also to the rising thinness of the plastics film between the fibers. As Fig. 1 indicates, polyvinylic fibers raise their breaking stress almost 7 times when their diameter is reduced from 11.10^{-4} cm. to 2.10^{-4}cm. (from 0.0004 in. to 0.00008 in.). A similar rise takes place also in plastics films when their thickness decreases. A thickness decrease occurs when the percentage of glass in the band rises. For instance for filaments 12.10^{-4} cm. thick the film thickness is only about $0.5.10^{-4}$ cm. when the band contains 80 volume-% of glass, and about 5.10^{-4} cm. when the glass content is 40 volume-%.

It follows from Fig. 1 that bands containing about 70 per cent of glass utilize over 50 per cent of its strength, that is more than do glass fabrics.

Bands on gelatin basis have a good flexibility and can be bent round a tube 1 cm. (0.4 in.) in diameter. Vinylic resin is the second from the point of view of flexibility, glyptal resin is the third, and asphalt is the hopeless fourth. Other combinations have not been tested in this respect. On the other hand gelatin swells in water, chars easily, etc. so that for all-round applicability glyptal and vinyl resins are the most promising ones.

TABLE II.

YOUNG MODULUS OF GLASS FIBERS BONDED WITH GELATIN

Percentage of glass	*Young modulus in kg. per sq. mm.*
12	400
40	1110
50	1700
58	2150

Single glass filaments, 22.10^{-4} cm. thick, had the total elongation of 2.7 per cent and the Young modulus of 4100 kg. per sq. mm. The total elongation of composite bands is very similar to that of the glass filaments in

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—The Holland Tunnel,* largest vehicular tunnel in the world, under the Hudson River between New York City and Jersey, was formally opened for traffic.

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them, but the Young modulus is the smaller the less is their glass content. Table II lists the results obtained with glass-gelatin combinations.

When, say 20 bands each 0.10 - 0.15 mm. thick are glued together to form a slab about 2.5 mm. thick, the ultimate tensile strength of the slab amounts usually to about 2/3 of that of the single bands, although in some tests no loss of strength had been observed. The best performance has been shown by slabs on glyptal resin basis. The breaking stress for slabs 2 mm. thick and 9 mm. wide (that is 0.08 x 0.35 in.) was approximately 70 kg. per sq. mm. (about 100,000 lb. per sq. in.). This value has to be compared with those (10-12 kg. per sq. mm.) for the best natural wood and those (22-26 kg. per sq. mm.) for wood impregnated with phenol-formaldehyde resin as employed in Russian aircraft construction.

Crushing strength of cubes prepared from bands glued together so that the filament direction was in every band perpendicular to that in the two neighboring bands, was found to be 20-25 kg. per sq. mm. for a vinylic resin.

In addition to their utilization in composite bands and slabs, glass fibers can play another part in constructional work. There exists a ferroconcrete in which steel is present as wires which are belasted in tension during the setting of concrete and therefore resist external bending forces. Glass ribbons can be substituted for these steel wires. The ribbons are made of parallel glass filaments, 12.10^{-4} cm. thick (1 part) and organic binder (1 part). Their cross-section is 1 sq. mm. (0.0016 in.). The ultimate tensile strength of a ribbon is 60-70 kg. per sq. mm. and the Young modulus is 2500 kg. per sq. mm.

INNIS, SPEIDEN NAMES EXPORT SALES MANAGER

In a recent announcement, Innis, Speiden & Company made known the appointment of Major Frank T. Shanahan as manager of the Export Sales Division.

Major Shanahan has been with the Transportation Corps of the U. S. Army for the last four years. Prior to that, he was a member of the company's sales staff.

Major Shanahan's office will be located at the company's headquarters at 117 Liberty Street, New York City.

PITTSBURGH PLATE GLASS APPOINTMENT

Appointment of Robert Wardrop as assistant manager of glass advertising and promotion for the Pittsburgh Plate Glass Company has been announced. Mr. Wardrop recently completed his terminal leave as Lieutenant Colonel after four years' service with the Army.

Upon his graduation from Princeton University in 1935, Mr. Wardrop joined Pittsburgh Plate Glass Company. Following a training period in various glass and paint plants operated by the company, he served as territorial salesman at Minneapolis. He was manager of the firm's Duluth, Minn., warehouse prior to his commissioning in the Army.

• A new German process for making fused quartz of precision optical quality is described in a report released by the Office of the Publication Board, Department of Commerce.

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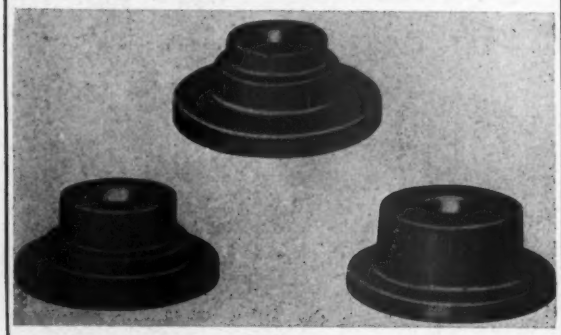

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CONTAINER GLASS OF HIGH ALUMINA CONTENT . . .

(*Continued from page* 293)

the most widely used method is to produce a carbon amber by adding carbonaceous materials to the glass batch. These glasses have a relatively low alumina content. The German type of Owens glass with its higher alumina is not suitable for carbon amber. In this type only grayish brown color shades can be obtained by the addition of carbonaceous materials to the batch. This led to the use of the manganese-iron combination for brown bottles. They are less expensive than the British and American types because of the much lower alkali content. Their application, however, is limited to hand-blown ware and to machines with suction feeding devices.

Manganese is introduced as pyrolusite. Its action as a flux allows lowering of the alkali content. The alkali content as a rule varies between 10 and 13% and the alumina content is 6-8%.

Encouraged by the success in developing green container glasses on the phonolite basis, the author studied the possibility of replacing soda-ash and sulfate by phonolite in order to develop low cost dark brown and amber glasses. No. 1, 2 and 3 of Table II are representative compositions of these brown bottle glasses as melted commercially during April 1931, February 1935 and June 1937.

TABLE II

		1	2	3	4
SiO_2	in %	58.12	57.06	56.94	56.82
Al_2O_3	"	14.74	15.01	15.28	16.03
Fe_2O_3	"	1.44	1.45	1.56	1.39
MnO	"	3.10	3.70	3.38	2.94
CaO	"	10.46	10.36	10.11	10.66
MgO	"	0.44	0.78	0.98	1.04
Alkali	"	11.10	11.24	11.08	10.76
SO_3	"	0.74	0.51	0.55	0.42
Acid test	mg.	57.0	74.0	97.0	73.0
Standard test	mg.	5.2	4.8	6.3	4.5

The composition could be changed so far that the batch would be free of soda ash and contain only the small amounts of sodium sulfate necessary for the fining of the melt. The batch composition of the glass No. 6 which was melted during 1939-1940 is given below.

Phonolite	600 kg.	Limestone	200 kg.
Sand	200 "	Sodium sulfate.	18 "
Pyrolusite	35 kg.		

The author emphasizes throughout his report the need for testing the acid resistivity of the glass, because minor changes in the alumina content of the sand might become detrimental for those glasses which normally contain about 16% alumina.

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GLASS DIVISION HOLDS ANNUAL MEETING . . .

(*Continued from page* 312)

The substitution of alumina for silica in a soda-lime-silica glass decreased the maximum rate of crystal growth for devitrite. The maximum rate of growth of wollastonite was at first unchanged by the substitution of alumina for silica but later increased.

The changes in rate of crystal growth with composition were qualitatively explained by considering changes in viscosity and liquidus temperature.

Lead Nickel Glass of Controlled Chemical Durability for Storage Battery Use. *By F. J. Williams and J. A. Orsino, National Lead Co., Research Laboratories, Brooklyn, N. Y.*

The addition of very small amounts of soluble nickel salts to the electrolyte of a storage battery markedly decreases the end-of-charge voltage. However, this effect is fugitive, disappearing in a few cycles. The problem of decreasing the end of charge voltage is thus one of continually supplying nickel ions to the electrolyte to perpetually renew the catalytic layer of nickel. Glass would be an ideal solution to the problem. This becomes apparent when the attack of solutions in glass is considered, particularly as to mechanism.

Considerable data on chemical durability of glass were available. These data might be summed in a number of generalities as follows: 1) The rate of reaction is roughly a linear to parabolic function of time. 2) The rate of reaction is a linear function of the surface area. 3) The log of the rate of reaction is a function of the reciprocal of the absolute temperature, or over short temperature ranges, it may be considered a linear function of the temperature. 4) The rate of reaction is a complex function of composition. (Generally, simple two and three component glasses have lowered durability.)

A lead silicate glass containing nickel was prepared on a laboratory scale and subjected to chemical durability tests. These solubility tests were sufficiently encouraging to suggest a trial of the glass in a storage battery. Consequently, a series of batteries was prepared, the negative plates of which contained nickel glass equivalent to a nickel content varying from 0.00006 per cent to 0.047 per cent. The results obtained showed that a nickel containing lead silicate glass when incorporated into the battery plate paste makes the effect on voltage permanent by continuously supplying nickel ions to the electrolyte and, moreover, improves the cold capacity of the battery during its life.

Selenium Ruby and Other Colored Glasses Employing Selenium as a Colorant. *By A. E. Pavlish and C. R. Austin, Battelle Memorial Institute, Columbus, Ohio.*

In this work, particular emphasis was placed on the determination of the factors necessary for the production of selenium ruby tableware on a volume basis in continuous tanks. All work was therefore done on a zinc-free base glass composition suitable for use in machine production. Some work was also done on the development of colors other than ruby by employing selenium.

Previous work had pointed out the possibilities of using reducing agents in the batch to effect controlled reducing conditions within the melt to retain selenium and cadmium in the requisite amounts. This line of attack was followed further in the present work. To a base glass of the following composition, Silica 72.8, Alumina 2.5, Calcia 6.4, Magnesia 4.2, Sodium oxide 12.6 and Potassium oxide 1.5, there was added various amounts of selenium, silicon, cadmium (either as sulphide, phosphate or metallic). In addition, sodium nitrate was also added to a few of the glasses. The melts were made in both commercial and laboratory day tanks using natural gas and a "soft flame". Melting and fining was accomplished in 13 to 18 hours at a temperature of 2700°F. The glass was then gathered, pressed in hand presses and, in the case of tests made at a commercial plant, run through a commercial glazer.

These large-scale trials confirmed the laboratory results as regards selenium content. Approximately 0.05 per cent Se is necessary to develop the ruby color under the condi-

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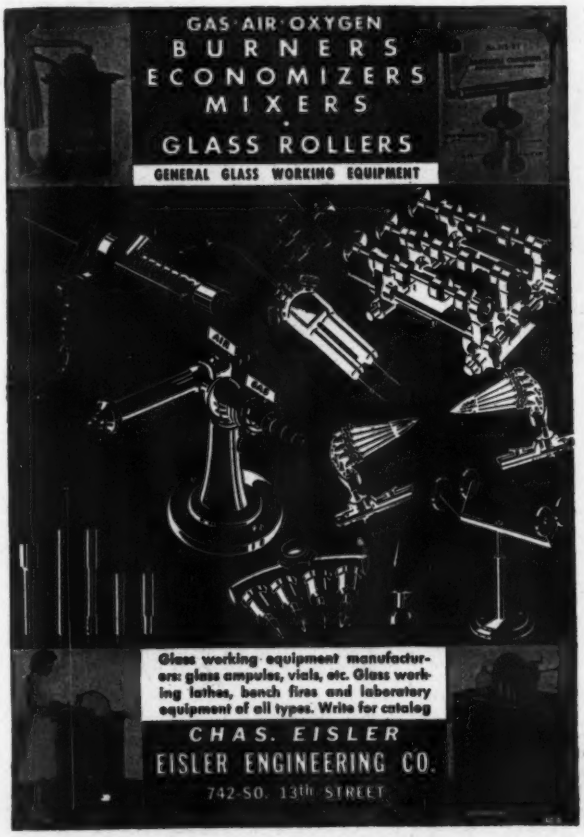
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